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OBSERVATIONS ON MALARIA IN NORTHERN ARGENTINE
WITH SPECIAL REFERENCE TO CASES OBSERVED
IN THE PROVINCE OF JUJUY.

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Thesis submitted for the M.D. Edin.

by

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Introduction.

In March 1908 I took up my duties as medical officer on a large estate owned by an English firm, Messrs. Leach Bros., in Jujuy, which province along with Salta are the two most northerly provinces of the Argentine Republic.

The province of Jujuy extends as far north as the Bolivian Frontier, 22° S. and extends as far South as 24.5° S. so that both tropical and semi tropical climate is met with.

It is bounded on the north by Bolivia, on the west by the provinces of Los Andes and Salta, south and east by the province of Salta.

I remained there until May 1911, thus making my term of residence in the province a little more than three years. During this time I resided in the small township of San Lorenzo. San Lorenzo is situated the foot of the Calilegna Mountain, a mountain of about 10,000 feet in height, which lies due north of the town. The town is about 20 miles south of the Tropic of Capricorn, practically on the same line with the Santos in Brazil, and its height above sea level is about 1,800 feet. Another mountain range bounds the town to the west, this latter range being irregularly continued into the Calilegna one,

in this way an irregular V is formed. Other and higher mountains are placed behind this V and loom up in the distance beyond, the highest peaks reaching an altitude of over 1900 feet. These mountains are known collectively as "Las Sierras de Juzy" and are all spurs of the Andies situated further to the west and dividing Argentine from Chili.

In the V thus formed the town of San Lorenzo is situated close up to the foot of the mountains, up whose sides the forest, that for the most part covers the surrounding low lying country, is continued for a considerable distance leaving the higher ranges bare and rugged, destitute of vegetation and during the winter at least snow capped.

The situation is an ideal one, not only from the point of scenic effect but also from a hygienic point of view, as in the manner described a large valley is formed between the two foremost mountain ranges, which extends back with gradual ascent and becomes lost eventually in the higher mountains, whose arid table lands and peaks are visible in the back ground, and in consequence of this formation a cool breeze frequently blows down the valley and through the town of San Lorenzo which helps to keep the air in circulation and makes the atmosphere less oppressive during the hot summer months when the thermometer

commonly registers 104° to 110° F. in the shade, and also to a considerable extent minimises the close, suffocating heat at night, which is a feature of the neighbouring districts less fortunately situated, though of the same latitude and altitude above sea level, and in this way certainly materially contributes to the health of the town, as refreshing sleep under these circumstances is impossible, and this when added to the moist heat prevailing during the day time has a very enervating effect on the system.

The population of San Lorenzo is approximately 2,000 inhabitants, of this number about two-thirds consist of native Argentines, some of whom are of pure Spanish descent, others, the majority, are of mixed Spanish, Indian and Bolivian extraction. The remaining one-third is made up of for the most part of Indians who come down long distances from their territory in the Chaco to work in the cropping milling of sugar cane which is the chief industry of the province. They are drawn almost entirely from three tribes, the Matachos, the Tobas and the Chiriguanas, and come to San Lorenzo about February, some time previous to the cropping of the cane, and live there in huts made of branches until crop is finished, about the end of October, then they again

return to the Chaco. There are also a small percentage of Bolivians at certain times of the year who come down from the hill district to work on the estate, they are chiefly employed in the clearing of forest land.

The English Residents all told, numbered 23 persons. There are also a small and varying number of Germans, Russians, Italians and Spaniards employed on the estate.

The formation of the country such as the extensive forest land, marshes, dry river beds, at certain times of the year, or rivers with here or there large still pools after the rainy season has passed, and an extensive irrigation added to the climatic conditions, such as heavy rains and a damp heat which prevailed at seasonal intervals, all greatly favoured the presence and breeding of mosquitos and in San Lorenzo in common with the greater part of the province anophelines formed a fair proportion of the indigenous species. The dwelling houses of almost the entire population, other than the English section, affording little or no protection against the attacks of these, Malaria of various clinical types is consequently prevalent. This applies especially among the Indians, who arrive in San Lorenzo at the period when malaria is most rampant,

further their encampments are usually located in the more infected foci as of necessity they must be placed on the outskirts of the town consequently are closer to the edge of the forest clearing. During the day their huts are fairly well protected from mosquitos by the smoke of their fires which are generally lighted inside but at night the mosquitos come out of their hiding places at the day time and infest the camp.

Added to the fact that the Indians are thus more exposed to infection they are more difficult to deal with from the point of view of Prophylaxis or treatment owing to their indifferent and obstinate ignorance.

While resident in San Lorenzo my duties consisted in medical attendance on this community and during that time I had every facility for proper treatment of my patients, placed at my disposal, including a small hospital of 10 beds erected after my arrival, so that in this way I could follow up and keep in touch with any cases of interest.

Also for approximately a year and a half I held the appointment of medical officer to a railway in process of construction to Bolivia (the F.C.C.N.) which passed through the San Lorenzo property and extended up country. It had reached Embarcacion a point some 98 kilometres distant from San Lorenzo,

during my term of office. The men employed in constructing this railway and their families lived in roughly put together huts made from odd and irregular pieces of boarding and covered with a zinc roof or perhaps simply under a zinc roof supported by poles. They had in this way no protection against mosquitos that breed extensively in the pools that formed after rain in the excavations made during the process of laying the earth works and sinking of wells. These conditions presented ideal possibilities for the spread of malaria among these people and as may be readily imagined, the disease frequently took on an epidemic character.

The total number of persons employed in this construction, men, women and children, numbered over 2,000 and a very large proportion of these were subject to attacks of malaria.

In addition to these two previously mentioned appointments I also had an appointment under the Argentine National Government in connection with the Campaign commenced early in 1909, in this province having for its object the stamping out of malaria by prophylactic & curative measures. My duties embodied the supervision of this movement in the San Lorenzo district.

In the latter three months of my residence in Jujuy

my duties were extended in this capacity to Yato a growing centre about 20 miles N.E. of San Lorenzo forming one of the stations on the Railway Line running through to Embarcacion, and the head quarters of the Argentine Hard Woods and Estate Co. Ltd., the entire population numbered 1,500 approximately. The company work a large saw mill and are engaged in opening up the forest land. The Tropic of Capricorn passes through Yuto so that my district presented both tropical and sub tropical climate. Consequently in the discharge of my various duties while resident in San Lorenzo I had an opportunity of seeing a considerable number of cases of malaria and of putting into practice methods for at least materially decreasing the prevalence of the disease in the district, and as a result of my work and observations deducted therefrom I hope the material gathered may prove of some use in advancing our knowledge of the disease.

In the present thesis I propose to describe the kind of cases I met with and my ideas of the etiology and treatment, both curative and prophylactic of malaria as encountered in the Argentine.

Historical Outline.

The word malaria, first introduced into the English language by Maccullock,¹ (Jones History of Greek Therapeutics and the Malaria Theory) who wrote on the subject some 80 years ago, is the name applied to that disease, the symptoms and pathology of which are due primarily to the presence in the blood of a multitude of minute animal parasites, of the class sporozoa. These developing at the expense of the red corpuscles produce attacks of fever usually intermittent but which may also be remittent or indefinite in character.

The outcome of modern research on the subject of malaria has had a far reaching influence on the accurate diagnosis and treatment, both curative and preventive of the disease, and has led up to the well organised anti malarial campaigns of recent years which have done so much towards decreasing it.

On the proving of the mosquito transmission theory of malaria, Ross studied the breeding habits of mosquitos in various parts of India where he observed that the anaphelines bred more particularly in small shallow pools and marshes and he pointed out that if, only the pools producing malaria, i.e. those containing larvae, were drained we had a cheaper and easier method of prevention than that of more universal

drainage ².

The result of his researches up to this point were embodied in a report to Government in 1899. In the same year he continued his research on this question in Sierra Leone in conjunction with Dr. H.E. Annet and Mr. Austen. They published their report on this in 1900, in which Ross recommends reduction of Anophelines by preventing breeding by means of drainage or filling in of pools or treating them with oil together with the destruction of adults or larvae. He also discussed personal prophylaxis by the use of mosquito netting, etc and pointed out that Europeans suffered by not being segregated from the natives in Africa. R. Koch during his visit to Italy in 1898 recommended another important means of prevention i.e. prevention by means of treatment of cases. He successfully carried out his method at Stephansort in 1900. He aims not at the reduction of the carriers of parasites but at attacks on the parasites themselves by general and complete treatment of all infected persons with quinine thus making the anophelines innocuous as they will not encounter parasites. ³. Another method adopted was the screening of houses by wire gauze, a defence against mosquitos long employed in America. This is now generally used; its utility was emphasised by experiment of L. Sambon and Low in the Campagna of Italy in 1900 and has been

widely used in Panama. In 1902 Ross undertook the prevention of malaria in Ismailia on the Suez Canal where efforts at prevention by the quinine method alone had already failed. He continued the existing measures but in addition instituted a general mosquito reduction of both culicines and anophelines and within a year the admissions of malaria reduced from 2,000 a year to 214⁴. Since then endemic malaria has entirely disappeared at Ismailia. Prevention of malaria has been carried out on these lines with marked success in various places, but probably among the most noteworthy are the American campaign by Col. Gorgas against malaria and yellow fever at Panama⁶ and that of Dr. Oswald Cruz at Rio Janeiro⁶.

At Panama the antimalarial work is principally rural, located for 47 miles along the line of the rail-road between Panama and Colon and the population is about 80,000 in this distance. This strip is divided into 18 districts under the sanitary organization schemes; each district is under charge of an inspector and each inspector has about 50 men under him. The antimalarial work consists in order of its importance of:

(1) Drainage, all pools to be drained and done away with, within 200 yards of villages and 100 yards of individual houses for this purpose subsoil drainage

was bound to be most effective and economical, second open ditches of concrete, and third open ditches.

(2) Brush and grass cutting. The tropical undergrowth was kept cut off to within 200 yards of villages and 100 yards of individual houses, and this area was kept less than 1 foot high.

(3) Oiling Oil was used where either drainage was too impracticable or too costly, such as edges of swamps or streams.

(4) Larvicide. A poison which mixes with water; was used in places where the oil could not reach the larval, e.g. grassy edges of ponds or streams.

Larvicide consists of crude carbolic acid, caustic soda and resin.

(5) Prophylactic Quinine. Quinine was freely distributed gratis by quinine dispensers among the men working in the various squads. On an average about half of those employed on the works got a prophylactic dose once a day.

(6) Screening. It was insisted that all Government buildings should be kept screened to be thus rendered mosquito proof.

(7) Killing of mosquitos in quarters during the day. The expense of this campaign against malaria worked out at about \$2 per head on an average of 50 years, and during that time the population averaged about 100,000. The results fully justified the expense. Among the

employees the malarial death rate fell from 11.59 per 1,000, Nov. 1906 to 1.23 per 1,000 in December 1909, and the admission rate per 1,000 for malaria among employees has been as follows: 1904, 125: 1905, 514: 1906, 821: 1907, 424: 1908, 282: 1909, 215.

Much has been done in Brazil in the prevention of malaria. The most important campaign was conducted by Drs. Carlos Chagas, Arthur Neiva and Gomez de Faria members of the Institute under the directorship of Dr. Oswaldo Cruz.

The prophylactic measures against malaria comprised the following:

(1) Prophylaxis by quinine exclusively adapted when the treatment had to be applied to a moving population and not one remaining any length of time in a particular zone.

(2) Preventative administration of quinine. Isolation of persons infected with gametes in Infirmarys fitted with gauze wire and unrelaxing treatment of those infected. This treatment was adopted when the persons already affected had to reside for some time in the infected zone with healthy people and where work was done more slowly.

(3) The same measures as above together with systematic sulphur disinfection of infected dwellings. Prophylaxis adopted when the staff remained for a

longer period in the infected zone and where it was not possible to carry out prophylaxis by means of larvicide.

(4) Indirect prophylaxis by war on mosquitos.

In their prophylaxis by quinine they gave 0.5 daily grammes of the hydrochloride and when a recurrent attack occurred following on wet weather gram i intramuscularly. The work of prevention in India has been extensively carried out and has given good results (No. 3 of "Paludism") the transactions of the committee for the study of malaria in India describes what has been done up-to-date in the fight against malaria in that country. The committee are now setting about the organisation of a special branch for the study of malario-metric investigations. The object is to arrive at some method of measuring the quantity of malaria in a district more accurately than we do at present, and propose the necessity of knowing more about the relationship of members of anophelines to the prevalence of parasites. The committee have decided upon asking the governing body of the Indian Research fund to approve an endeavour to obtain from England an entomologist for the bionomical investigations and a worker recommended by Major Ross for the malario metric inquiry (B.M.J. Oct. 14th 1911 and Oct. 28th 1911)⁸. This scheme when carried into

effect should still further assist in lessening malaria in India.

The connection of South America with the history of malaria is of considerable historical interest, as during the conquest by the Spaniards in the 17th century cinchona bark by which the Indians had successfully treated the disease for a long time before, was brought to European notice. This bark was formerly called Jesuit bark, as that order, who were instructed in its use by the natives of Peru, were the first to introduce it to Europe (1637).

The Botanical name was derived from that of the Countess del Cinchon, the lady of a Spanish Viceroy who had been cured by it. The tree from which it is obtained is native to parts of South America, it grows abundantly in the forests of Quito and Peru. It has since been introduced into India, Java and West Indies⁹.

Peruvian bark was tried medicinally in Spain as early as 1639 but its employment in fevers to which it was unsuited and ignorance of the proper form of administration led to its discredit even among some of the medical profession.¹⁰ (Creighton History of Epidemics in Britain Vol II p. 320)

Later, however, Pelletier and Coventon extracted the alkaloid quinine and by acting on it with sulphuric

acid isolated the neutral salt, quinine and sulphate. This did away with the necessity for large nauseating quantities of bark which had been taken by patients hitherto, while Forti and Sydenham (1753) worked out the dosage and method of administration. Thus Morton and Forti by the introduction of cinchona were able to differentiate between malarial fevers on the one hand and febrile diseases in general on the other and in this originating with the discovery of Peruvian bark a great step was made in the advance of our knowledge of the disease¹¹.

The further researches of Laveran, Meckel,, Virchow, Golgi, Celli Marchiafava, Ross, Manson, Grassi, Bignamie and Bastianelli and many others, as already mentioned, have furnished us with our present knowledge of the disease and led up to our modern methods of treatment, both curative and preventive, which have done and are doing so much towards stamping it out.

Malaria, referred more particularly to the Argentine Republic.

The scientific nomenclature in Spanish is "Paludismo" or "fiebre paludica," but it is known popularly in the Argentine and Bolivian Republics as "chucho" the etymology of which word is found in the language of

the ancient Incas, (quichna" being derived from the Indian word "chui" meaning "cold," hence the significance of the name chucho is obviously found in the rigors and cold sweats which are characteristic features of the disease¹².

The history of malaria in Jujuy dates from the time that cultivation of coffee and sugar cane was started, that is about 35 years ago when the first plantations were put down on anything approaching a large scale in San Pedro, Ledesina and Calilegua (San Lorenzo).

It is impossible to obtain accurate data of the exact distribution and character of malaria prior to this period.

The town of Ledesma which is situated about 4 miles from San Lorenzo (see map No. 1) and today has a population including the surrounding district of 6,000 was formerly a military fort, founded because the surrounding country was principally occupied by Indians, according to accounts furnished by those first engaged in the clearing of the forest land and cultivation, malaria was rife in that time, none of those engaged in these works or then holding more responsible offices escaped. The ~~pious~~ and their families living under worse hygienic conditions were similarly attacked.

The types of fever were extraordinarily serious and persistent, it is impossible to obtain exact data of the existing clinical forms of the mortality but one is led to suppose that the greater part of the cases were intermittent fevers of a tertian character. This supposition is based on the fact that the word *terciana* "chuco" was as much in general use as the word *terciana* as a name for the disease¹³.

The generally accepted idea of the cause of the malaria was the ancient theory of Miasmas. It was often accounted for as indeed it still is among the natives of to-day as due to the eating of green fruit, especially oranges, water melons and sugar cane. It is still laid down to-day as a "sine que non" that any one eating oranges before the 1st of June is certain to be attacked. Indeed, even to-day among the other residents the same belief exists. They maintain that when the sugar cane planting was first started and the sugar mills first erected in Esperanza and Ledesma there were practically no mosquitos and yet malaria was rampant among them, consequently they are sceptical as to the mosquito transmission theory, inclining rather to accept the view that the malaria is spread by insects other than mosquitos and also by eating green fruit, and also adhere to the old theory of Miasmas.

As regards the treatment then in vogue it was considered essential to take a cathartic before the administration of quinine, now was the quinine very much pushed as when a rapid cure was not effected recourse was had to emetics, sudorifics and various bitter infusions especially to a decoction of the bark of a tree indigenous in the north of the Argentine - quebracho blanco. It seems that about the same time malaria was equally prevalent and under similar existing conditions in "San Pedro e Esperanza" which to-day has a population of 8,000 and Calilegua (San Lorenzo). San Pedro is about 36 miles S.W. of Calilegua¹⁴ (Las fiebres paludicas en Jujuy" by W.C. Paterson, "Anales del Departamento Nacional de Higiene" March and April Nov. 1911).

Endemic Malaria in the Argentine.

In a country such as the Argentine which is situated in the southern portion of S. America lat. 22° S and 52° S. long. 53° and 73° E (Greenwich), where one finds existing great differences in altitude and vegetation and a variety of climatic conditions from tropical heat in the north to extreme cold in the south one can readily realise that malaria is found endemic in some places and not in others.

There is a large belt of malarial infested country extending from north to south traversing the provinces

of Salta, Jujuy and Tucuman and extending as far south as the provinces of Catamarca and Riofa. The centre of this malarial zone may be represented by a line almost straight that passes from north to south, from Oran in the province of Salta, Campo Santo, Metan, Rio de las Piedras (also in Prov. Salta) and Francas, Vupos, Fanaailla, Monteros and Rio Chico in the prov. of Tucuman. On either side of this line throughout its entire length the degree of endemicity gradually diminishes to the East and West as to the east lies the sparsely populated Chaco While to the west lie the mountainous country of the Andes and its various spurs. The districts of San Lorenzo, Ledesma, San Pedro lie close to this line.

Of the 25 provinces and national territories into which the Argentine is subdivided we find malaria endemic in 11. viz.

Provinces of Salta, Jujuy, Tucuman, Catamarca, La Riofa, Corrientes, Santiagodil Estero, Cordoba, San Luis. and in the national territories of Misiones and Formosa. In the first three provinces mentioned we find malaria more prevalent and generally a greater relative proportion of severer types.

The southern limit of Endemic malaria may be put 32.2° S. to which corresponds the isotherm 19° from this boundary in the south to the Bolivian frontier in the

north malaria increases in frequency.

Epidemic Malaria. In the epidemic form malaria has been observed in almost every province of the Republic. Dr Rawson¹⁶ has stated that in the capital, Buenos Aires, on the site of the present Park of Palermo which before being reclaimed was low lying and swampy, malaria existed during 3 months in the year. Further, at the present day cases of malaria are not unknown to medical practitioners, among patients who have never left the city of Buenos Aires.

Again, in San Felipe situated a short distance outside the city of Tucuman where one finds conditions especially favourable to the presence of malaria, Dr. A. Soldati had the opportunity of observing an epidemic of severe character, which presented many of the features of Asiatic cholera, some of the cases being serious and which he stamped out by free use of quinine administered from both a curative and prophylactic point of view, out of 100 cases which he treated by large doses of quinine. Only one death occurred, while before his treatment was adopted two medical practitioners were treating the epidemic solely on anti cholera lines, with the result that 20 deaths had occurred and the disease was rapidly gaining ground. It is regrettable that one is unable to find any microscopic data relating to this epidemic,

though it is worthy of note that prophylactic measures were energetically carried out, large doses of quinine being given each morning to each healthy person with the result that no new cases occurred and the epidemic was soon controlled.

¹⁷ The entire population of San Felipe numbered about 600 ("Contra la Paludisma"). We also have evidence of malaria showing a marked tendency to spread south in the Republic, of late years in a manner that well establishes its infective character.

It has made its appearance during the course of 1900 in Santiagodel Estero, in 1901 and 1902 in certain parts of Cordoba and Catamarca and La Rioja where it formerly was unknown. In the city of Cordoba the medical practitioners state that they have observed only cases imported from the north which sometimes actually take on the form of small epidemics¹⁸; the question of the tendency to spread south is a serious one, as practically all the provinces present conditions favourable to the breeding of mosquitos.

Again, in the north the tendency is to spread, in parts where it formerly did not exist we now find it, e.g. the Chaco. Some eight years ago two Englishmen personal friends of my own, made an expedition lasting six months into the heart of the Chaco in search of Indian labour. In Rividavia one of the more import-

ant points of the Saltanian Chaco where they remained some time. Malaria was there unknown though the anopheline mosquito was present, nor did they encounter malaria among the Indians during the expedition; yet to-day malaria is not uncommon in Rividavia and surrounding districts, last year (1910) I treated two patients from Rividavia for malaria apparently contracted there, from them I also learned that mosquitos flourish in the numerous small lagoons and malaria is apparently not uncommon. The spread in this direction can readily be accounted for by the Indians becoming infected with parasites during their residence in Jujuy and on returning to the Chaco in their turn infecting the anophelines. Embarcion the present head-quarters of the Railway construction work, is bordering on the Chaco and here malaria is prevalent so that people coming down to this centre from the Chaco and surrounding country as they frequently do are exposed to the risk of infection.

Etiological Considerations.

The malarial rate of a locality is largely influenced by the proportion of infected mosquitos to the number of inhabitants in any given locality.

The measurements of malaria in a district may be arrived at by various methods such as ascertaining the (1) parasite rate and index of the population, (2) the spleen rate and index, (3) combined parasite and spleen index, (4) fever rate and index (daily, monthly or annual)¹⁹.

The results of examination of the blood in children for parasites is frequently taken as a gauge of the prevalence of malaria in that particular district.

An examination of the blood of children born in Jujuy shows the presence of parasites without clinical symptoms of fever, but not such a relatively large proportion as in other countries, for instance, Ollwig found in children up to 5 years, 57.3% with parasites present in his examinations made in Dar-es-Salaam (Prev. of Mal in German possessions by Dr. Prof. Claus Schilling)²⁰ Koch and other authorities found in certain districts of Africa 50% of the native children with the parasite in their blood, but only a small proportion of them presented clinical features of malaria at the time of examination.²¹

Examination of the blood in children as a means of

calculating the malarial index in San Lorenzo (Jujuy). The examinations were made during the most malarial months of the year, viz. January to March of the years 1909 and 1910. One is forcibly struck by the difference between these percentages and those already quoted of Koch and Ollwig. The tables are as follows:

Table No. 1.

1909.

Month.	No. of Children examined under 4 yrs. of age.	Parasites present in	Percentage.
January.	31.	0	0
February.	37.	4.	10.88
March.	40.	4.	10

Percentage for the year calculated on the monthly
percentage - 7.4

Table No. 2.

1910.

Month.	No. of Children examined under 4 years of age.	Parasites Present in	Percentage.
January.	26. 1.	1.	3.8
February.	11.	1.	9.09
March.	20.	3.	15

Percentage for the year calculated on the monthly
percentage - 8.7

These percentages are small but all the children were in attendance at the consulting rooms suffering from slight illnesses of various natures but none showed any symptoms of malaria. So that if I were to add to these percentages the percentages of those children under 4 years, with parasites who at time of examination were suffering from malaria, there would be a considerable rise. So that taking this into account I think the method gives one a fairly accurate representation of the amount of endemicity present, as on referring to table no. 5 (as published in Contra la paludismo) we see that 98.5 per 1000 of population were affected in the year 1909 which works out at about 98%. The splenic index among children probably gives a rather more accurate estimation of the exact amount of malaria present, it is somewhat higher than the percentage of parasites.

The tables are compiled from the same cases in both instances.

Table No.3

1909.

Month.	No. of Children examined.	Enlarged Spleens.	Percentage.
<hr/>			
January.	31.	2.	6.4
February.	37.	6.	16.2
March.	40.	9.	22.5
<hr/>			

Percentage for year calculated on the monthly
percentage - 15.7

Table No. 4.

1910.

Month.	No. of Children examined	Enlarged Spleens.	Percentage.
January.	26.	3.	11.5
February.	11.	3.	27.2
March.	20.	5.	25.0

Percentage for year calculated on the monthly
percentage - 19.3

By this method the percentage is more nearly approaching that found to exist in Africa, and I think is more accurate than the calculation based on examination of blood as after all it is more difficult to detect parasites in the blood than a condition of enlargement of spleen and not infrequently parasites may escape microscopic detection though really present in the blood of persons examined, and then again, a certain number will lose the parasites after administration of quinine. Of course splenomegaly may be due to causes other than malaria, but the percentage of these cases is so small that as a practical point it may be disregarded in the San Lorenzo district.

Table No. 5 shows the measurement of malaria in San Lorenzo during the year 1909, made on the relation

existing between the number of cases recorded for the year and the population of the town itself (not including the Calilegua Railway encampment)

Table No. 5.

	Population.	No. of Malarial Cases in year 1909.	Malarial index.
San Lorenzo (town).	2,000	316.	15.8%

It will be noticed that this malarial index practically coincides with the splenic index among the children taken in the same year, as shown in Table No. 3, viz. 15.8% in the one case and 15.7% in the other.

Predisposing causes of Malaria in the Argentine.

Primarily these are factors which predispose to the existence of mosquitos in a locality supplemented by an inefficient protection against them on the part of the inhabitants.

The factors are:

1. Climatic conditions.
2. Geographical and geological formation of country.
3. Hygienic conditions.
4. Vegetation.

The Climatic Conditions.

The temperature, rainfall, humidity of atmosphere and wind velocity are all factors which influence the occurrence of malaria in the Argentine.

The temperature and rainfall seem to be the more important of these, they seem to have a definite relationship to one another, for instance one invariably finds that with a high average rainfall the average temperature is correspondingly high.

This fact is well emphasised in the relationship which exists between them in the narrow zone 1.5° in width which comprises the part of the Republic North of the Tropic of Capricorn, as starting from the Eastern frontier with mean average annual temperature of 23°C . we cross the isotherm at right angles and arrive at the western limit with a mean annual temperature of 14°C . The rainfall following the same course has diminished from 1600 m.m. to less than 50 m. On referring to the various tables recorded by the meteorological society one finds that this applies generally throughout the Republic (Climate of the Argentine Republic W.C. Davis 1900)²².

The average maximum temperature during summer in Calilegua is about 30°C in the shade and a degree or two higher in Yuto.

Conditions favour mosquito breeding most in the warmer months as towards the end of spring summer

and the greater part of autumn. In the winter months I seldom found mosquitos, I believe they remain as Larvae and hatch out the following spring and so supply the first generation of mosquitos. This applies equally to anophelines as to the other families. The reason is that the water temperature is too low for the hatching of the eggs during winter while in the warmer months of spring, summer and autumn it is suitable. In San Lorenzo (1800 feet above Sea Level) in winter the water temperature of rivers is often as low as 2°C . in the early morning, and the surface water is only a degree or two higher, while on the other hand it is often 30°C . in the summer. (Temperature of water in which mosquitos will breed in

In winter possibly a certain proportion of mosquitos hibernate in houses and suitable places in the forest as described by Annet who found maculipennis anophelines hibernating in cellars in south of England²³ (see hibernation of mosquitos in Pract. Study of Malaria Stephens and Christopher, P.). I have looked for them in Jujuy but have been unable to find them, probably because evaporation is too great and the insects dry up. I have found that if the insects be put in cages they live 3 days, but if in bottles they will live 7 and if fed as long as 14. This may be explained. I think by the drying effect the atmosphere

has on them when exposed to it as is the case in the cages, in the bottle on the other hand it is moister.

The number of cases of malaria occurring in the district of either San Pedro, Ledesma or San Lorenzo was much greater in the hot weather than in the cold and any cases occurring in winter are probably recurrent cases and not fresh infections

Ross thinks that high temperature acts to increase the amount of malaria by increasing the mosquito output, also the biting factor is increased ~~and the recovery factor is decreased~~, consequent on exposure to heat or sun, he explains the fact that lower latitudes where the temperature favours mosquito breeding all the year round often have a lower malarial index than higher altitudes which only permit of breeding in the summer as statistics show to be true in parts of India, by pointing out that all the mosquitos in the lower altitudes need not necessarily be carriers although they are anophelines as all species of anophelines do not carry malaria. (Ross Prevention of Malaria p. 191 and 192)²⁴ As all the anophelines indigenous to Jujuy are carriers, the higher temperature will have a direct influence on malarial increase during the hot months though doubtless we have the indirect factor present also.

Argentine Seasons.

Winter - June, July, August.

Spring - September, October, November.

Summer - December, January, February.

Autumn - March, April, May.

Humidity of atmosphere. Moisture in the atmosphere when associated with a fairly high temperature certainly favours the propagation of mosquitos in the parts of the Argentine where the heat is dry as in San Luis mosquitos appear to flourish to much lesser extent than in the provinces of Tucuman and Jujuy. I have also frequently been struck by quantities of mosquitos one finds near pools of water in the depths of the forest, ^{the} Where the undergrowth is of a tropical nature and the atmosphere damp and hot, this I noticed more especially in the tropical part of the Argentine during an expedition in the country north of Oran. The mosquitos in common with insect life generally were much increased under these surroundings.

Wind Velocity: A high wind will often carry the mosquitos quite a distance by a series of short flights as noted by Col Gorgas (Malaria Prevention on the Isthmus of Panama)²⁵. The high winds often occurring round San Lorenzo were undoubtedly a means of spreading malaria more especially when the Indians were encamped round the town, as the infected mosquitos were thus conveyed from the Indians to the natives and vice versa.

Rainfall. This also has an influence on the relative amount of malaria pressure in Jujuy. The rainy season commences in November and lasts to March or April. With an average rain fall of 592 m.m. according to the statistics of the meteorological society as recorded in Jujuy, though I must say that during my residence the rainfall has been higher than this (see table No. 6 which shows 707 m.m. for 1909) and according to careful records kept by myself in San Lorenzo with the ordinary funnel rain gauge, 40 inches of rainfall from December 18th 1910 to April 31st 1911 though I must admit this period was considered exceptionally wet.

The other months of the year are almost devoid of rain. We thus get large pools of water formed during the wet season which in some instances allow time for the breeding of mosquitos before absorption or evaporation takes place. The amount of time necessary for this in Jujuy is 12 to 14 days.

Table no. 6.

1909.

Month.	Average Maximum Temperature 1896- 1900	Average Rainfall (in millimetres)	No. of Cases of Malaria.
Jan.	39.4 ⁰ C. (unable	082 m.m.	250.
Feb.	38.3 ⁰ C. (to ob-	252 m.m.	140.
March.	36.1 ⁰ C.. (tain	048 m.m.	187.
April.	33.3 ⁰ C. (statis-	144 m.m.	274.
May.	30.5 ⁰ C. (tics for	0.28 m.m.	170.
June.	30.5 ⁰ C. (year09 ,	003 m.m.	102.
July.	32.3 C. (these are	0 m.m.	86.

Aug.	36.6 ⁰ C.	(taken	0m.m.	100.
Sept.	38.8 ⁰ C.	(from	018 m.m.	85.
Oct.	39.0 ⁰ C.	(Davis	018 m.m.	84.
Nov.	39.8 ⁰ C.	(Climate	026 m.m.	57.
Dec.	39.7 ⁰ C.	(of Ar-	106 m.m.	77.
		(gentine		
		(Republic,		
		(an aver-		
		(age on		
		(the yrs.		
		(1896-1900)		

Total.	707 m.m.	1612.
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Table No. 7.

1910.

Month.	Average Maximum Temperature	Average Rainfall for yrs. 1904- 08 inclusive.	No. of Cases of Malaria.
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Jan.	SEE	152 mm. 173 mm. (10)	101.
Feb.		50 mm. 064 mm. (10)	160.
March.		131.6mm. 270mm. (10)	362.
April.		39 mm. unable to	195.
May.		23 mm. obtain	150.
June.	ABOVE	2.6mm.	73.
July.		4.4mm.	52.
Aug.		0.6mm.	83.
Sept.		12.4mm.	66.
Oct.		22 mm.	54.
Nov.		45 mm.	87.
Dec.		101 mm.	85.

Total.	583.6 mm.	1468.
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Tables Nos. 6 and 7 serve to show the influence exercised by rainfall and temperature on the amount of

malaria in a district. The rainfall recorded is obtained from the report of the National Meteorologic al Society, the readings been made for the province at the third station in San Pedro (Esperanza) and the temperature readings from Davis Climate of Argentine Republic 1900, and the number of cases recorded represent the entire number ~~annated~~ in three districts of San Pedro, Ledesma and San Lorenzo.

Again, on referring to table No. 8 compiled from statistical records kept in accordance with the National defence against malaria in the provinces mentioned and from statistics of the Meteorological Society (Climate of the Argentine, Davis 1900) one sees that on the whole the same relationship obtains generally throughout the Republic.

Table No. 8.

Prov. of Jujuy		Salta.		Tucuman.		La Rioja.		Cordoba.	
1896-1900.		1882-1893.		1855-1900.		1875-1892		1873-1900	
Annual Temperature.	Av. R.F.	Annual Temp.	Av. R.F.	Annual Temp.	Av. R.F.	Annual Temp.	Av. R.F.	Annual Temp.	Av. R.F.
21.97 °C.	563.4 m.m.	17.47 °C.	560.5 m.m.	19.28 °C.	965 m.m.	19.62 °C.	273.6 m.m.	17.08 °C.	697.5 m.m.
98.5		80.1		53		15.3		1.76	
Number of cases of malaria per 1,000 of population in yr. 1909.									

Geographical and Geological Formation of Country as
Influencing Factors in the occurrence of Malaria.

In many parts the formation of the country is suitable and indeed often ideal for the breeding of mosquitos. For instance one meets with numerous mountain ranges especially in the west where the Andes send out their minor chains or spurs which serve as the water sheds of various rivers in the clear water of the back eddies and pools of these, one finds excellent breeding places for anophelines, provided the altitude is not too high and the temperature of the water consequently too low. Altitude is an important factor, I never found or heard authentic account of Endemic Malaria existing in the province of Jujuy, at any rate, at a greater height than 2,000 metres. I have found a few anophelines at Yala, a place up in the Jujuy mountains (2,000 m. above S.L.) and the child of some friends of mine became infected there. I have not come across mosquitos at any higher altitude than this. Hirsch²⁶ has given data on this point with regard to the limits in other countries. In Germany he states that 400 to 500 m. is the highest altitude at which one will find malaria existent. In Italy 600 to 1,000 m. while in the Andes of Peru, malaria can be found at a height of 2500 m. above S.L. at higher altitudes than these the mosquitos cease to exist. (Contra el Paludismo)

The numerous streams and rivers taking their origin in the various mountain ranges and in the rainy season containing often huge volumes of water as is so frequently seen in Jujuy, is a fruitful cause of malaria, as in the low lying land the water often overflows the banks and forms large pools where mosquitos breed. This is especially true of the San Lorenzo district or, indeed, any district where irrigation is carried out on a large scale, a large area frequently becomes flooded in this way. Again, in the dry season, these river beds frequently dry up leaving here and there pools of water where breeding may occur. The fact already mentioned that the country is being extensively opened up, is an important cause of malaria, as it leads to excavations as seen in connection with the laying down of railway lines and putting up large buildings, such as the sugar factories of Esperanza, Ledesma, Mendieta. The buildings at Yuto and the consequent massing together of communities of people in these various places.

The soil round the particular centres of San Pedro, Ledesma and Calilegna is for the greater part clay or sandy, generally speaking does not exceed a depth of 3 metres, occurring over a subsoil of indeterminable depth formed of gravel, that in Calilegna, at any rate has a depth of 70 metres. On this account in the

immediate vicinity of these three towns, San Lorenzo, San Pedro and Ledesma, there are no lagoons or large deposits of water that will resist evaporation and filtration for any length of time. Still, further out, from these centres, one not infrequently meets lower lying swampy land, where the ground water is close to the surface, forming numerous big springs and sometimes more especially during the wet season forming lagoons. The ground water by reason of the surrounding mountainous country will in the lower lying valleys sometimes have a high head of pressure and consequently bursts to the surface. In these places, small lagoons are common enough and these mosquitos flourish; a good example of this is found in the Cienagas of Chanar Solo (meaning swamp) about 4 miles distant from San Lorenzo. Here also a lagoon exists and anophelines are very numerous. There are only two dwelling houses in this neighbourhood occupied by men in charge of cattle and their families, with them malaria was very prevalent.

The Existing Hygienic Conditions as a Predisposing Cause.

The dwelling houses of the natives, at any rate, in the rural and semi urban districts, afford no protection whatever against the attacks of mosquitos. The typical Argentine Rancho is met with in the rural districts and also on the outskirts of nearly all the

small towns, particularly round San Pedro, Ledesma and San Lorenzo, consists usually of a thatched roof, usually of brush wood, supported on pillars, there may or may not be mud walls but in any case there are no doors and thus a free entrance is presented to the mosquito which finds an ideal hiding place by day in the dark under the thatched roof, and as the inhabitants of the houses rarely use mosquito nets they are totally unprotected from their attacks at night.

Then again, the Indian's huts already mentioned are hot beds of mosquitos as although the mosquito is driven out by the smoke from the fires lighted inside during the day time, yet at night, when the fires are allowed to burn out the huts having open doors and usually situated on the outskirts of the town, as is the case in San Lorenzo, close to the forest and, in the instance of one encampment close to some large pools of water kept for the purpose of seasoning wood in before sending it to the sawmill. In this way Indians soon become infected, more especially because coming as they do from a practically non-malarious country - the Chaco - there is no element of immunity among them, as is the case with the native Argentine born within the malarial zone, they on this account more readily succumb to inoculation.

Further the Argentine custom of having open wells in the yards or situated close to the better class country houses, usually with the troughs full of water close by which may go undistributed for a considerable period or also various receptacles full of rain water are further sources of danger.

It is a very common thing to see pools of water close to houses in which breeding of mosquitos is allowed to take place without any attempt at prevention being made, for the reason that among a great section of the community malaria is not associated with mosquitos and frequently if this relationship is appreciated the inhabitants are too **indolent** to endeavour to prevent it.

Vegetation.

The dense undergrowth seen in some parts of the forest when associated with water seems to be marked by the presence of large numbers of mosquitos and if a house is found in a clearing in such a place the mosquitos make the lives of the inhabitants almost unbearable. Mr. Walter of the Mauritius Observatory has proved statistically that the damp exhaled from trees increases the number of rainy days, especially the afternoon rainfalls common in the tropics. On this account alone trees favour the breeding of mosquitos²⁷

Then again, the various algae occurring in the breeding places favour malaria in as much as they are a food for the larval forms of mosquito.

Mosquitos Indigenous in San Lorenzo and Surrounding

District:

Anophæles. (Anophæles pseudopuncti-pennis.
(Cellia albipes.
(Cellia argyrotarsis.

Culex - Culex fatigans.

Panoplites - Panoplites titillans.

Stegomyia - Stegomyia fasciata.

This classification has been given me by my friend Dr. Paterson of San Pedro and I have been able to verify it in my own district of San Lorenzo, with the exception that I have never seen Panoplites titillans. I have included it for the sake of completeness. Dr. Paterson found them in considerable quantity close to the San Pedro river in 1907 but since that date has had seen any of the genus. I have looked for them repeatedly round San Lorenzo but always without success so that I am led to believe that they do not exist there.

The classification of the anophæles I believe is a full one as although during my 3 years residence I have looked in all likely places and at all seasons

of the year most carefully I have never encountered any others of the genus. Of the three species of anophelines mentioned, *Anopheles pseudopunctipennis* is the most abundant and practically speaking is the only one concerned in the spread of malaria in this district. The other two species are so rare that as a practical factor in the spread of malaria they may almost be disregarded, but they both exist in and round San Lorenzo.

Anopheles Pseudopunctipennis;

The biology is in general as that of the other species of anophelines. They breed in clear water preferably in water containing certain classes of multicellular algae, especially the genus *spirogyra* on which plants the larvae feed extensively. Clear water containing the unicellular *Vancheria* does not appear to be so favourable. I do not mean to imply that the larvae are found only in water containing *spirogyrae* but they most certainly seem to favour those places where it occurs, during the summer months any deposit of clear water will quickly become a medium in which *spirogyra* flourishes, spreading quickly by spore formation and thus forms an ideal breeding place for *anopheles Pseud-opunctipennis*. (for Botanical characteristics of *Spirogyra* and *Vancheria* see Henfrey's Botany P437) ²⁸.

The most common breeding places of these anophelines are the streams, marshes and springs, these places present favourable conditions as during the summer they are very frequently covered over by spirogyrae which on account of the light and heat acting on the chlorophyll cellules and causing formation of bubbles of oxygen are kept floating on the surface. The larvae are enclosed in the meshes of the net work thus formed and so are not only supplied with food but also with an extra supply of oxygen in as much as they breathe in a well oxygenated atmosphere. Other places that embody these conditions are found during the rainy season especially at the sites of brick cutting operations here large pits are formed owing to the earth being removed to be baked into bricks and in the pools of water which form in the pits at the sides of the railway track from which earth has been removed to level off the earth-works on which the rails are laid, also in wells or tanks filled in which is collected rain water for drinking or washing purposes. A striking exception to this is found in the water tanks erected for the purpose of supplying the Railway engines at various stations along the line. These are large tanks with a capacity of about 25,000 feet and are placed on top a stone work erection about 20 feet high. I have never at any time of the year found larvae

in these, this I think cannot be put down to the fact that some of the water is withdrawn daily, as the amount withdrawn is small in comparison to the total amount contained in the tank and the requisite time for the transition of the egg to the larva is only 3 days. Again, there are water tanks in Esperanga also placed at a high level in order to give at head of pressure to supply the sugar factory and in the summer this water is very little disturbed as the factory is not then working and here also mosquitos do not breed so that I am led to believe it is a question of the height above ground and that the *Anopheles Pseudopunctipennis* will not lay their eggs or frequent water placed at a height above ground.

During the rainy season the springs are very numerous in the country around San Lorenzo, especially at the foot of banks or in low lying places surrounded by hills or higher land where filtration may occur and pools of clear water are thus formed in which *Spirogyra* quickly grown and in a short time mosquitos begin to breed.

This genus of Anophelines does not as a rule breed in muddy water on this account during the rainy season we do not find them in the numerous small canals which in San Lorenzo or, indeed, any well cultivated district form a network of small water courses for the purpose ,

of irrigating the land, but not unfrequently the water overflows the banks of these water ways and forms pools at the sides where after the mud has settled before complete evaporation and filtration has taken place the mosquitos frequently breed. This I have found to be the case in connection with the irrigation of the "alf-alfa" fields to the west of the town (see map2) but does not occur in connection with the sugar cane planting (see under "summary").

But although it is the exception I believe *Anopheles pseudopunctipennis* will occasionally breed in fairly muddy water when there is no other breeding place possible, as once in San Lorenzo during the rainy season when all the water, with the exception of the filtered drinking water, was muddy, one of the English residents who lived in the same house as myself went away on a fortnight's leave of absence leaving his washingbowl full of muddy water in his bedroom with the doors and windows closed. There happened to be some *Anopheles Pseudopunctipennis* in the room and they, during his absence, breed in this water. He afterwards called my attention to the fact and certainly though a good deal of the earthy matter in suspension in the water had settled yet the water containing the larvae was far from being clear.

It is further stated by Ross that *Anophelines* will

not breed in the water contained in various receptacles round houses. (See Ross "Prevention of Malaria" p.30 and 31)²⁹.

I found that this frequently did occur round San Lorenzo as when I first went there I found they breed freely in various deposits of rain water contained in some old earthenware jars of large size which had formerly been used in the process of sugar making on obsolete lines, also in various old iron tanks lying round the house which was a large one storied building covering a large area of ground and built in the form of a hollow square with a court yard in the centre. Several of these receptacles contained water of a distinctly stagnant character and yet were full of anopheles pseudopunctipennis and also stegomyia, the Anopheles Pseudopunctipennis larvae being readily distinguished by their position in the water, i.e. horizontal to the surface on account of the position of the breathing tubes.

They also breed in certain ponds containing drinking water for the animals found in the outlying uncultivated grazing land.

The marshes lying to the north east of San Lorenzo (see map 1) known as "La Cienaga" which lies at a considerably lower level than the town and receives the overflow of the surface for mosquitos, there are

other similar breeding places around San Pedro district. These permanent breeding places produce the greater ^{the} number of mosquitos during the early months of malarial season and these mosquitos afterwards deposit their eggs in the pools, etc. formed by the rains. In the rainy season the mosquitos born in the rivers deposit their eggs in the pools formed in and round the centres of population and vice versa, during the period of the floods, the greater number of the larvae are washed down the rivers, but when the rains cease the smaller streams and also the rivers become contaminated again from the mosquitos born in the pools and in this way the cycle is continued.

Characters of Anopheles Pseudopunctipennis.

It is dark in colour and varies in size according to the time of its incubation. The length of the adult body is 5 m.m. and of the hind legs 15 .m.m. The females are larger than the males.

Antennae. Curved, 13 articulations, the last being the longest and most delicate. The segments are covered with short hairs and the articulations have 4 longer hairs.

Palpi. The same length as the proboscis and made up of 4 segments. The first two of which are of equal length, the 3rd and 4th are shorter, the first

or basal segment is covered by numerous small scales. The apex is yellow and these are yellow streaks in the articulations.

Occiput. Covered by pointed scales, white, with a tuft of white hairs directed towards the point in the direction of the proboscis at the sides of the occiput there are large black hairs mixed with scale provided with double points.

Mesothorax.

Two tufts of white fusiform scales symmetrically arranged each side in a perpendicular direction.

Metathorax.

Is bare.

Scutellum.

A band of rigid hairs, no scales.

Abdomen is elongated and segmented.

Wings are narrow at the base and blunt pointed. The anterior margins are straighter than the posterior, which are somewhat curved. They are marked by branching scaley striations running in a longitudinal direction - the veins - The veins give the surface an irregular, patchy appearance as they are coloured yellow in some parts of their course and black in others. ~~See diagram.~~ The mottling is least marked. On the inner one-third of the wing more so than the middle one-third, most of all in the outer one-third.

The margins of the wings are marked by yellow interruptions which are the terminations of the veins.

The Legs are of uniform darkish colour with points a little clearer in the joints.

Characters of the Egg (Anopheles Pseudopunctipennis)

The female lays from 50 to 100 eggs. When recently laid they are white, but soon take on a brilliant gray colour. During the dry season they do not take on this appearance. The eggs are found floating on the water collected together in small colonies but later owing to the slight movements taking place in the water the colonies become broken up and the individual eggs separate out and arrange themselves in the form of stars or triangles.

Generally a certain number of the eggs are badly formed and do not produce larvae. If examined through an ordinary pocket lens the eggs are seen to be formed in the shape of a boat with one extremity thicker than the other. The head of the larva appears from the thicker end. The length of the eggs vary from 0.8 to 1.0 m.m. By experimenting with mosquitos the shut up in a cage it will be seen that the females prefer to deposit their eggs on objects floating in the water, a leaf or paper, etc and will deposit them in any water collected in the cage. Probably this applies to them in their natural state also, though I have not

been able to confirm it, but in all probability it does. If one puts clear water and turbid water, side by side, in the cage they invariably will deposit their eggs in the clear water. Sometimes mosquitos shut up in the cage will lay eggs even in the absence of water and these eggs retain their white colour and do not produce larval. The following facts are also readily demonstrable. Water cooled with ice delays indefinitely the production of larvae.

Parrafin oil or ordinary oil such as olive on the surface of the water will not prevent the hatching out of the larvae but they die very shortly after.

Under ordinary conditions the larvae hatch out in 2 days and are the same length as the egg when born.

Characters of the Larvae.

The larvae take up their position horizontal to the surface of the water. The colour depends on the food and the depth of the water. In pools of considerable depth or in slowly running water the colour is green, the food consisting of green algae floating on the surface.

To the naked eye they appear like very minute little sticks floating in the water dark or greenish in colour. When disturbed they make their escape by a series of rapid movements for the surface or for the bottom seeking to hide themselves in the algae.

The resting position is characteristic. The posterior extremity remains in contact with some object in the water thus the head floats free and by a constant movement of the "whiskers" the small particles of food are carried to the mouth.

Out of the water the larvae will live only a very short time, but in mud they can live for a day or even two days sometimes.

last

The larval stage, under normal conditions about 15 days. This may be prolonged, however, by cold or want of food. In the case of adult larvae the transition to the nymphal stage seems to be hastened by the want of food, but in young larvae, on the other hand, it retards the transition up to 3 weeks or more. Cold will retard the transformation indefinitely, the larvae becoming lazy and do not feed so actively.

The nymph stage lasts generally 3 or 4 days, after this the mosquito comes forth at any hour of the night or day. The proportion of males to females varies. If one takes nymphs from the pools and keeps them under observation until the mosquitos appear, the females predominate. By breeding larvae under artificial conditions from the egg the males are more numerous among the resulting mosquitos. There do not appear to be any characters distinguishing sex in the larvae.

Habits of the Adult Mosquito.

When in the resting posture both the male and female take up the position characteristic to anophelines that is with the body almost at right angles to the resting surface. (Manson "Tropical Diseases" p.149)³⁰.

Under artificial conditions one can preserve the female living for 10 to 12 days if she be allowed a feed on blood, but the male will die in 2 to 3 days as it is a non sucker.

Also as already mentioned the mosquitos will live longer in a glass jar than under the ordinary cage as the textures of the insect dry quicker in the cage.

Under natural conditions the females only feed during the night. But if one be enclosed in a glass tube and inserted over the skin they can be induced to feed and it is interesting to note that they show a marked preference for the more ~~odoriferous~~ skin of the Indian.

The mosquito will not suck blood until 48 hours old. It is the custom of the anopheles to enter the house just before the night fall and when the doors and windows of the houses are provided with wire gauze netting, one can see considerable numbers settled on the netting trying to gain an entrance especially if there be a light inside the window. At the same time



one finds the mosquitos that have entered the night before trying to make their escape from within, at this time one may kill a great number. After complete darkness more of those that have survived will be found on the network before the following night. Generally speaking they will not bite except during the dead of night, certainly at any rate their attacks are much less frequent towards the dawn. Complete darkness is not necessary as they will bite even with a light in the room.

After having fed, a certain number make their escape at day break but the majority of those that are filled with blood remain in the same room until evening, and these are to be found during the day hidden away in dark corners, under beds, and wardrobes and especially among dark clothes. During the day they are lazy and if disturbed only fly a few feet before again pitching.

Even when there are a large number of anophelines present in a room they do not attract attention by a continuous hum as is seen in the case of the culicines or stegomyia, these latter species before attacking a human being with a view to sucking blood advertise their presence by flying round their victim for some considerable time before biting and in so doing set up a continuous hum giving one the impression that they

are afraid to bite. But in the case of the anophelines there is no previous warning. The mosquito comes from a distance off and plants himself directly on the site he has elected for attack; even when awake one may be bitten by the genus anopheles without being aware of it, nor do they cause so much subsequent irritation as do the culicines and stegomyia.

These points are useful in relation to the opinion that malaria may exist without mosquitos. It is seen that mosquitos may be present in large numbers and bite freely without attracting much attention.

It is interesting to note that anopheles pseudopunctipennis is also one of the principal malarial carriers in Panama. These are classified by S.T.Darling and are:

A. Albimanus; A. Argysotarsis; A. Pseudopunctipennis; A. Tarsinaculata. (S.Darling, papers 1909-10 Section 65(4))³¹.

Cellia Argyrotarsis is found during the colder part of the malarial season, generally at the beginning and end, approximately at the beginning and end, above the months of November and April. Its breeding places are clear pools of water situated in shady places, where there is protection from the sun's rays, under trees, etc.

Cellia Albiplies is a still rarer species than the

Cellia Argyrotarsis and is seen more frequently in the colder months. Owing to its rarity it is impossible to formulate any concise facts regarding its breeding places and habits, etc.

Clinical Types and Parasitology.

The following forms of malaria occur in San Lorenzo in common with the province of Jujuy generally.

1. Quartan Infections (Parasite *Plasmodium Malariae*).
 - a. Simple quartan.
 - b. Double quartan.
 - c. Irregular forms.
2. Tertian Infection (Parasite, *Plasmodium vivax*).
 - a. Simple Tertian.
 - b. Double Tertian. (quotidian of Tertian origin).
 - c. Irregular forms.
3. Aestivo-Autumnal (*Laverania Malariae*).
 - a. Sub Tertian or malignant.
 - b. Quotidian Infection, a variety of the Sub-Tertian.
 - c. Many irregular forms, almost all the sub-continuous or continuous.
 - d. Bilious Remittent and algid forms.

These fevers do not differ materially from those described as occurring in other malarial countries. The pernicious types are comparatively rare, though the algid forms are not uncommon especially of the choleraic type.

The malignant types only occur practically speaking in November and December, January and February, March, and April. Chiefly at the end and beginning of the

year, as will be seen from table of statistics of cases in years 1909 and 1910, the country being sub-tropical. I found the Sub-Tertian types more constant among the families residing near marshy land as for example near Las Cienegas or San Lorenzo. (see map No. 1).

Parasitology.

The morphology of the parasites does not differ from the types corresponding to other malarial countries. The one exception is in the case of the Tertian Parasite (*Plasmodium Vivax*) in which differences in the number of spores are frequently found which indicates that there are different varieties of this parasite in existence. In every case of Tertian infection one sees some differences in the form of sporulation, the number of spores varying from 15-25, 25 being the most usual number. But in cases occurring in Jujuy it is very common to find the number is only 12-15, together with other morphological differences. (According to Manson's classification modified from Mannaberg, this is also described Tropical Diseases 1907).

Normal Tertian Parasites.

- (1) 25 spores.
- (2) Corpuscles increased.
- (3) Presence of Granules
of Schuffner.

Atypical.

- (1) 12-15 spores.
- (2) Very little increased.
- (3) Absence.

Treatment.

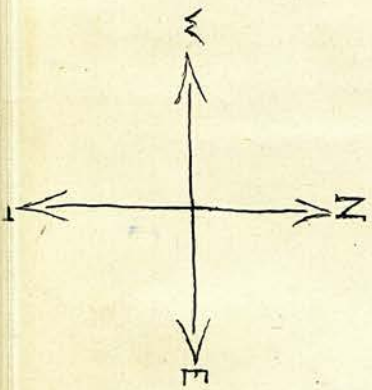
(a) Prophylactic.





The resources placed at my disposal by the Argentine Government with a view to clearing the district of malaria were as follows:

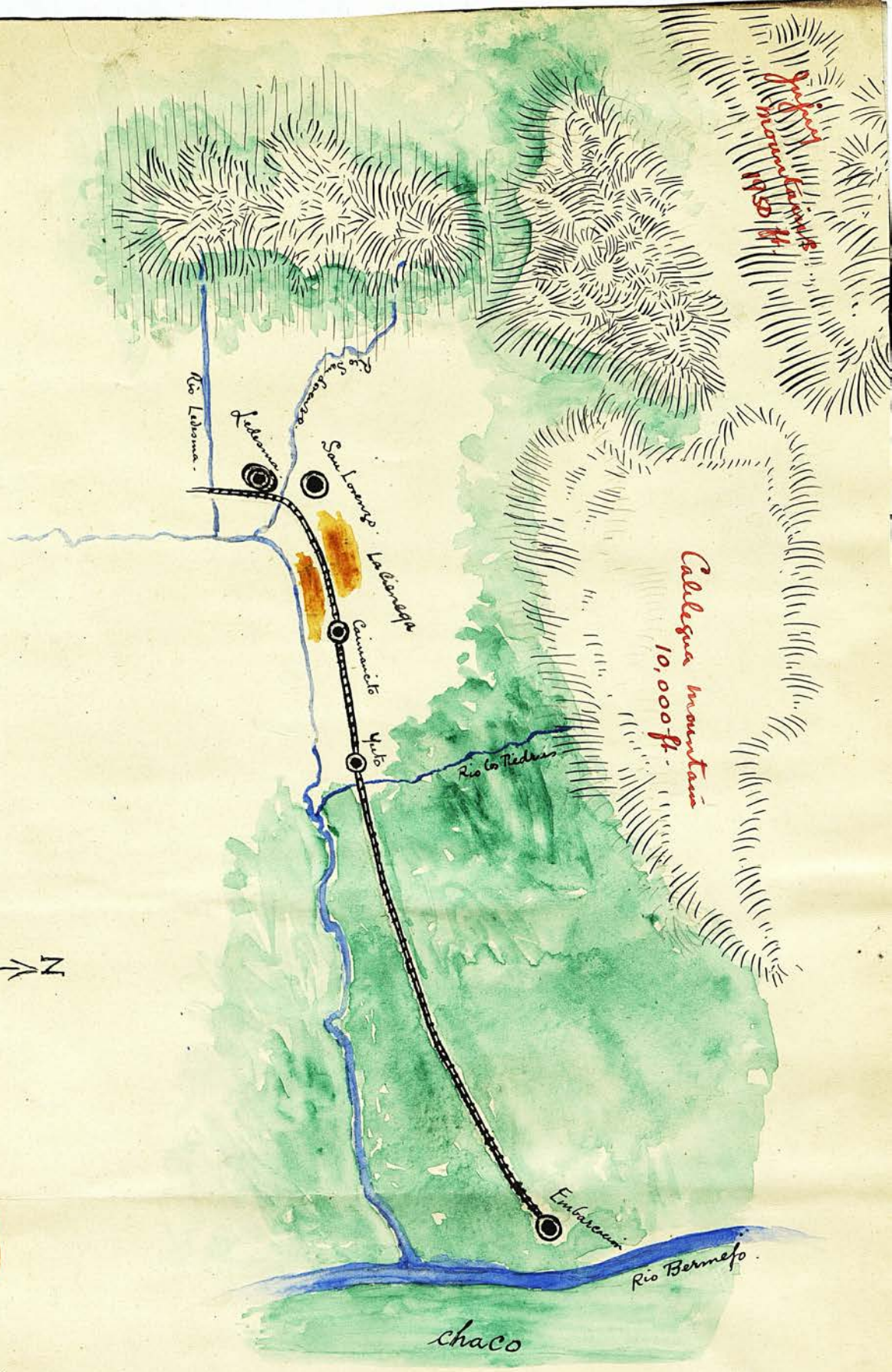
1. Wages of 2 persons at rate of \$2 a day each, the usual working wage in these parts.
2. A practically unlimited supply of quinine in the form either of Bisulphate or Bi Hydrochloride, put up in compressed tablets of gramme 0.5 each.
3. An adequate supply of crude petroleum, obtained from a local petroleum mine and known colloquially by the Spanish name of "Brea" (pitch). It somewhat resembles pitch in appearance being a thick greenish black liquid, floating on the top of water forming a thin surface film in the way of cutting off the supply of atmospheric oxygen from the mosquito Larvae and in this way asphyxiating them.
4. Mosquito nets for distribution among the natives with a view to personal prophylaxis, but the supply was very limited.
5. "Gastos Movimientos." A fund of \$40 per month to be used to defray working expenses, such as tools, hire of carts, etc.

But on taking into account that the malarial district over which I had supervision had an area of about 50 square leagues, it will be readily appreciated that

Map No. 1.

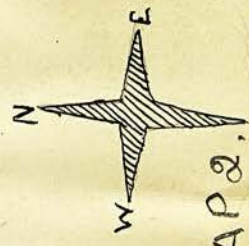
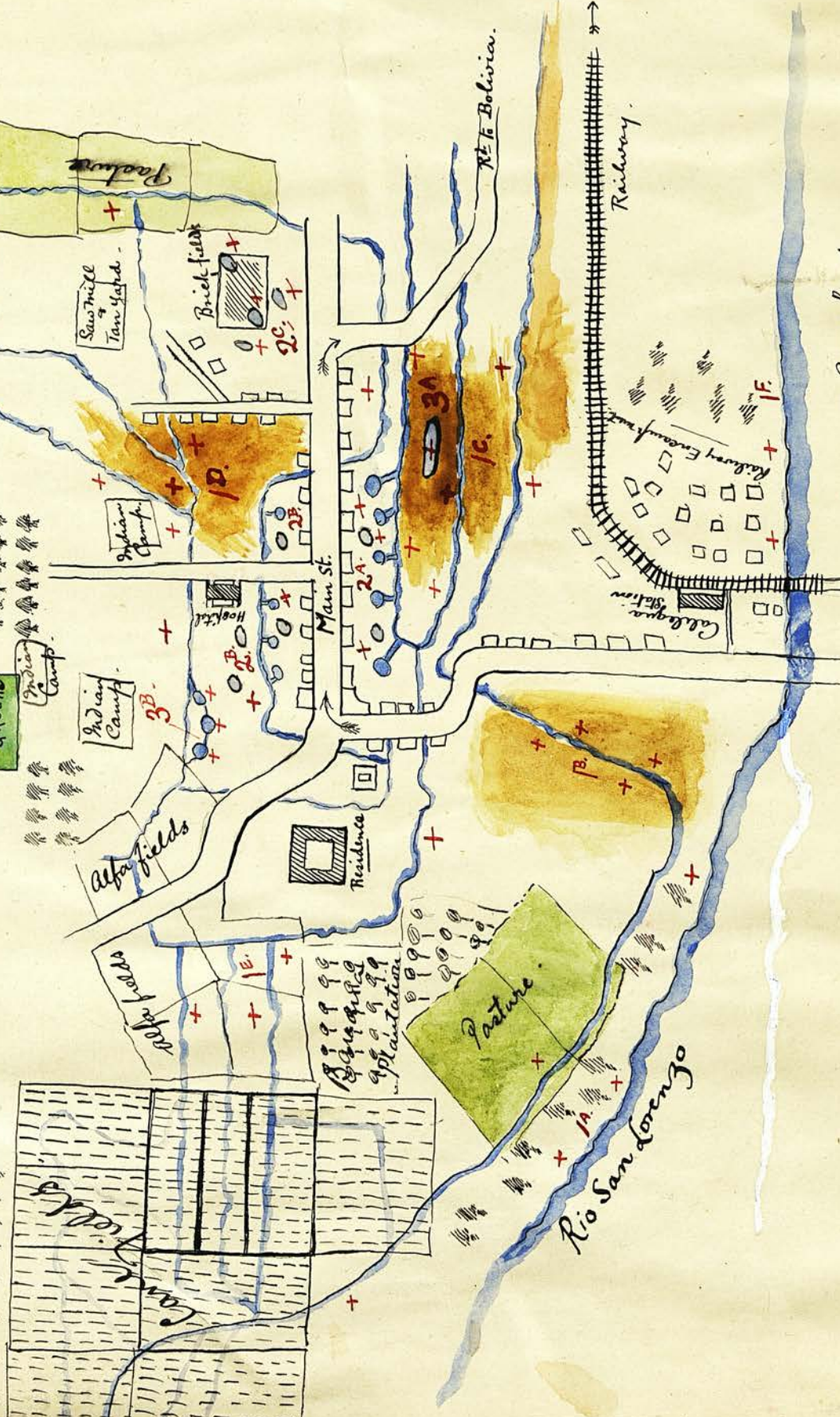


-  MARSH. [Las Cienegas]
-  FORESTLAND.
-  RIVER & STREAMS.
-  TOWNS
-  RAILWAY
-  MOUNTAIN PEAKS & RANGES



open country

(4)



+ = Larvae found
 1 A, 6 F } = Mosquitos found
 2 A, 10 C }
 3 A, B, (4)
 = Epidemic Guatara while clearing forest land.

[Blue Box] = River & System of Irrigation.
 [Orange Box] = Marshy land.
 [Green Box] = Pasture land.
 [Hatched Box] = Forest land.
 [Square] = Houses & huts.
 [Double Line] = Main Roads & Streets.
 [Circle] = Ponds of water.
 [Cross-ticks] = Railway.

MAP 2.

the means at my disposal were too limited to cope efficiently with the question of total abolition of malaria in this huge tract of country which owing to the railway construction then in progress had of necessity a considerable number of scattered inhabitants in addition to the several fairly populated cantres of San Lorenzo, Calilegna, Railway Station, Caimancito Railway Station and further up the line still on the confines of my district, Yuto. (see map No 1). But I was able at least to very materially lessen its prevalence in San Lorenzo itself in particular.

I began by making an inspection of the town and surrounding neighbourhood including the Calilegna Railway Station encampment situated about 600 yards to the South with a view to locating the places where mosquitos and larvae were to be found and subsequently concentrating the means at my disposal on these places in the first instances.

Map No. 2 shows a plan of the town and immediate neighbourhood with all the infected foci marked by a red numeral where mosquitos found and by a red cross where larvae present.

It will be seen that for the most part the waterways run parallel with the main street of the town. These I found in most instances to contain a quantity of long floating grasses growing out from the edges

9p/ and also aquatic plants which often harboured larvae and sometimes mosquitos but not to a very great extent, the exception being in the case of the main river, Rio San Lorenzo (See map No. 2) and where the waterways ran through marshy ground as shown in the map (1^A, 1^B, 1^C, 1^D, 1^E, 1^F.)

To cope with this I had all weeds thoroughly cleared out and the superfluous sediment dug out to prevent the formation of pools of sluggishly flowing water, owing to the sediment becoming dammed up, especially liable to occur in flood time, where there was a small gradient and so cause the overflowing of the banks and formations of pools of water alongside.

I also found the natives were in the habit of making little artificial dams in the waterways at the backs of their houses in order to facilitate the drawing of water for washing purposes, etc., these I had removed.

I periodically made an inspection of the cleared water courses to insure their being kept in that condition. Lastly I fixed old canvas sacs ~~sak~~kaed in crude paraffin (Brea) in mid-stream at distances of about 200 yards which gave off a constant supply of paraffin for a couple of days thus forming a scum on the water over the whole surface which flowed downstream, every few days the sacs were redipped.

The various receptacles for rain water in the way

of old pots, pans, tanks, etc. on the premises of the various houses, almost invariably contained larvae and not infrequently those of anopheles contrary to the usual teaching (Ross Prevention of Malaria, 1910)³².

All these I had emptied of contained water and turned upside down to prevent refilling.

These steps very much lessened the number of anopheles in the dwellings, especially in the English residences, as did also the throwing down of some old walls surrounding them and so allowing free circulation of air.

The ponds marked (2^A, 2^B, 2^C,) in map in every case contained larvae chiefly stegomyia and culex but also a fair proportion of anophelines and the houses in the immediate neighbourhood harboured mosquitos. These ponds were deep and of considerable size, being excavated when the houses were being built and filled later either with rain water or water from the stream running parallel with the street. To drain them owing to lie of larvae would have been impossible and to fill them would have been a laborious task. Now, in connection with the working of the Tan Yard (marked T.Y. in map) there is a large quantity of tannin yielding barked, the bark of an indigenous tree known as the seville tree, employed; this bark after the tannin has been extracted in the process of tanning the

leather, is cast on one side and in the course of years had formed an immense heap of dry finely broken up bark. In this I found an excellent substitute for earth for the filling in of above mentioned ponds, as it was light in the handling and so particularly adapted to carting and as it also had a large capacity for absorption of moisture it answered the purpose admirably.

The marshy ground marked in map I readily drained into the water courses and rendered quite dry.

The 4 ponds marked (3^A and 3^B) in map, were used for the purpose of seasoning logs of wood prior to cutting them in the sawmill and on that account were indispensable in all these I found anopheles larvae in abundance and also adult mosquitos. Here I was reduced to clearing out aquatic plants and petrolisation. In the case of the three marked (3^B), one was connected with the other by short channels and the 1st and 3rd ponds were connected with one of the water ways following close by, so that a current of water circulated in the 3 ponds flowing from the water way into No. 1 from No.1. to No.2, No.2 to No.3, and from No.3 into water way lower down, consequently by fixing an old sac soaked in paraffin in each little connecting channel a film of paraffin spread over the surface of each pond.

An excellent substitute of petroleum is found in the Cactus plant growing abundantly in three parts, macerate the fleshy leaves in water which can be done in big tubs or barrels. This solution which has a gummy consistency when applied to the surface of water forms an impermeable layer on top to the air and so destroys the larvae. (Journal of Tropical Medicine and Hygiene No.)³³.

During the rainy season of 1909 which in that year began in February and lasted into May, there were a number of men employed in the estate in clearing forest land. The camp marked (4) on the map was situated on the outskirts of the forest.

The number of inhabitants in this camp were all told about 70. The work included the felling of the timber and the digging out of the roots of the trees, in this way holes were formed in the ground capable of holding rain water. Also in the process of carting away the logs to the saw mill deep ^uroots were cut in the soft ground by the carts which also filled with rain water. In these pools and ~~an~~ophelines already present, quickly bred and the whole camp became infected with malaria of an epidemic form. Sub-Tertian fever principally. Steps to materially diminish the mosquito breeding were difficult to take as the season was a particularly wet one and the work had to continue, but by the use of mosquito nets and prophylactic doses of

quinine to each individual for two successive nights each week gramme 1 of the Bisulphate per adult and children according to age, the fresh infections were considerably lessened.

In addition to prophylaxis by reduction of mosquito population in ways above mentioned and by quinine given in gramme 1 doses on two successive nights each week per adult during the malarial season. Much was done among the European community by the protection of the dwellings with wire gauze netting, but this is not always practicable in the case of the natives owing to initial cost and formation of the houses. In the houses protected by wire gauze I also obtained excellent results by fumigating the rooms with Formaline Vapor. This done every 2 weeks will keep the rooms almost entirely free from mosquitos, a certain number of which will always gain an entrance owing to the doors being left open by servants, etc. For the carrying out of this I used the ordinary Formaline disinfecting lamp, consisting of a cup striped receptacle in which the formaline tablets are placed and under which a lamp is burned. Fifteen tablets are sufficient to kill off all mosquitos contained in an ordinary sized room, first taking care to have all cupboards and presses opened and doors and windows as nearly hermetically sealed as possible.

Giles recommends the following for fumigation of mosquitos: a mixture Saltpeter 1, charcoal 1, sulphur 8, a little gum water is added and whole is burnt. Sulphurous ~~acid~~ being formed (Giles, gnats)⁴¹.

In connection with the railway construction the problem of prophylaxis was a more difficult one to deal with, as here one was dealing with people who were constantly being moved from one place to another along the line, ~~infection~~ was in this way the more readily spread and one of necessity lost touch with individual cases. The constant mobilisation of empty covered in waggons carried mosquitos from place to place as did also the personal baggage of the employees. The large excavations made along the side of the railway track in order to supply earth for levelling off the earthworks and which in the rainy season fill with water are usually found to contain anopheles larvae. The adequate drainage of these would have entailed too great an expense , I was therefore reduced to petrolisation and even that necessarily for a limited distance, and the recommendation to Government that the filling in or suitable drainage of these excavations be made compulsory before the time be passed as fit for public service, as I believe is enforced in India (Journal of Tropical Diseases and Hygiene).³⁴.

In all the railway camps I emphasised the importance

of having no small pools of water in the immediate vicinity. But I depended most on the prophylactic administration of quinine and the use of mosquito nets. I issued quinine in the Government compressed tablet form to the foreman of each gang and had grs.XV of Bisulphate given to each adult on the two successive nights each week and children according to age. These men and their families lived mostly in huts with zinc roofs which in the hot weather conducted heat to an almost unbearable pitch and I noticed that in the frequently occurring spells of hot weather malaria the inhabitants of these huts suffered more from recurrent malaria than did the natives living in huts or houses having more non heat conducting roofs of mud or thatch. The probable explanation being that the increased heat and stuffiness under the zinc roof lowered the personal vitality and rendered the inhabitant more susceptible to either recurrent or primary attacks. One had evidence of this if called upon to spend any time under such a roof in the headache or limpness that followed.

I first noticed this predisposing factor to malaria during three weeks continuous spell of hot weather, that we had in January 1909 when there was an average maximum temperature of 104⁰ F. without any rain falling. The number of cases of malaria occurring

among the inhabitants of the zinc roofed huts was out of proportion, greater than occurred among those living under thatched or mud roofs; Although the exposure to mosquito bites was equally great in either case.

Since then I strongly recommended to the railway officials that the covering of the zinc roofs with a thick thatch of brush wood be insisted on and I think the result justified this measure.

Another recommendation I made was that all covered-in railway trucks, waggon or carriages before leaving one encampment for work or storage at another, should be disinfected by having sulphur burned in them with the doors tightly closed; in this way any contained mosquitos are destroyed. This measure I think helped to prevent spread of infection from one camp to another.

Table No. 4.

Date, 7/5/10.
Name.

Name.

[illegible]

Table No. 9 shows the result of prophylactic treatment I carried out by quinine alone in the case of a gang of 12 men, 10 Russians and 2 Turks who were engaged in clearing forest land near Yuto. The men were emigrants and came under my care about 1 month after their arrival in the country. It will be noticed that prior to this treatment they suffered a good deal from malaria and at the time I commenced treatment every one except S. Mahomet and Cubenski were down with fever for the most part, malignant, but during the period of treatment (7th May to 22nd July) only 2 of the men had recurrent attacks. The line of treatment differed slightly from that I usually adopted as I gave it on 6 successive nights in the beginning of the course, instead of the usual 3. I deemed this advisable as the general hygienic conditions of the men were of necessity very bad. Of course I am aware the number is unfortunately too small to be laid down as statistical, but nevertheless is interesting as going to prove the efficacy of quinine in prophylactic treatment and further, malaria was not so prevalent in the months of June and July, yet a great many recurrent attacks occurred among other gangs of men.

The efficiency of quinine in lessening prevalence of malaria is well shown when one compares the number of

cases of malaria recorded in the Province of Tucuman and amount of quinine used per head, on the one hand with the corresponding statistics in Province of Jujuy, on the other in the year 1909. Prov. Of Tucuman - 54.7 cases of malaria per 1,000 population, average quantity of quinine used per patient was 7.74 grammes.

Prov. of Jujuy - 98.5 cases of malaria per 1,000 population, while average quantity of quinine used per patient was 7.81 grammes.

(A. Barbieri - El Paludismo y sue Moderna Profilaxis)³⁵

In the prophylactic treatment of malaria by quinine, Koch and the German School recommend large doses at longer intervals, while Ross, Celli and the Italian School recommend small doses of quinine given daily. (Ross, Prevention of Malaria 1910)³⁶

The following statistics show the number of cases of malaria occurring in San Lorenzo and district (population approx. 3,000) during the years 1909 and 1910.

In 1909 and 1910 I carried on the campaign against malaria under Government and statistics show the results obtained. Unfortunately during the year 1908 I only kept record of the number of cases occurring in the month of May, so that I am unable to show as graphically as otherwise would have been the case, the benefit accruing to the district from the institution of the campaign. However, the fewer cases of malaria in

1910 (280) as compared with 1909 (414) together with the larger number in May 1908 (72) (before prophylactic measures instituted) than in either May 1909 (34) or 1910 (16), show a good result, there being a steady decrease of cases.

1909.

Month.	Quartan.	Tertian.	Aestivo	Prim-	Relapse.	Total.
			Autumn- al	ary at- tack		
Jan.	4.	18.	26.	9.	39.	48.
Feb.	6.	22.	30.	1 10.	58.	68.
March.	2.	16.	41.	17.	42.	59.
April.	-.	19.	38.	14.	43.	57.
May.	2.	14.	18.	11.	23.	34.
June.	-	6.	5.	--.	11.	11.
July.	-.	4.	9.	13.	13.	13.
Aug.	-.	4.	7.	--.	11.	11.
Sept.	-.	--.	2.	--.	2.	2.
Oct.	-.	4.	15.	--	19.	19.
Nov.	-.	12.	24.	6.	30.	36.
Dec.	2.	18.	36.	10.	46.	56.
						<u>414.</u>

1910.

Jan.	2.	16.	22.	6.	34.	40.
Feb.	5.	11.	23.	11.	38.	49.
March.	2.	18.	32.	4.	49.	53.
April.	-.	14.	11.	0.	25.	25.
May.	-.	4.	12.	3.	13.	16.
June.	-.	--.	14.	--.	14.	14.
July.	-.	--.	--.	--.	--.	--.
Aug.	-.	--.	12.	--.	12.	12.
Sept.	-.	9.	9.	--.	9.	9.
Oct.	-.	8.	10.	--.	18.	18.
Nov.	-.	14.	10.	4.	20	24.
Dec.	2.	10.	8.	5.	15.	20.
						<u>280</u>

1908.

Month.	Quartan.	Tertian.	Aestivo-Autumn.	Total.
--------	----------	----------	-----------------	--------

Jan.				
Feb.				
March.		NOT	KEPT.	
April.				
May.	12.	37.	23.	72.
June.				
July.				
Aug.				
Sept.		NOT	KEPT.	
Oct.				
Nov.				
Dec.				

This shows considerable fall in the malarial index due to the prophylactic measures adopted.

Malarial index, San Lorenzo & District. 1909 = 13.8%

" " " " " " 1910 = 813%

Malarial index calculated on the month of May.

1908 =	28.8%
1909 =	13.6%
1910 =	6.4%

(b) Curative.

The drug "par excellence" for treatment of malaria in its acute stage is quinine either given in the form of one of its various salts or the alkaloid itself, quinine in the basic state, (Journal Tropical Diseases and Hygiene No. 22 Vol. XII)³⁷ which contains 95% of anhydrous quinine as against the 73.5% of the sulphate. In San Lorenzo I have used the salts only.

The following table gives a category of the salts I used together with their solubility, percentage of alkaloid contained and equivalent value to quinine sulphate (Tabulated from Manson, "Tropical Diseases" 4th Ed)³⁸ ("British Pharmaceutical Codex" 1907)³⁹.

Table No. 10.

Name of Salt.	% of Alkaloid.	Solubility in cold water.	Amount equivalent in value to one of quinine sulphate.
Sulphate.	73.5%	In 800 parts. ⁷	1.00
Bi-sulphate.	59.1%	In 11 parts.	1.24
Bi Hydrochloride.	72%	In 1 part.	1.02
Hydrochloro Sulphate.	74.3%	In 2 parts. ⁴	.99
Ethyl carbonate or Eu quinine.		Sparingly soluble.	

The more soluble salts I used by preference in the acute attacks of malaria on the grounds that the quinine is more quickly taken up by the blood and thus a more lethal effect produced on the parasite. For this reason I used the Bisulphate, the Bihydrochloride or the Hydrochloro Sulphate formed by prescribing quinine sulphate in solution with acidum Hydrochloricum dilutum. This latter I used largely until the Government issued the Bisulphate and Bihydrochloride. I made up a stock bottle in concentrated form to facilitate dispensing,

adding Tinct. Cardamon Co to the prescription as a colouring and flavouring agent. In this way the taste of the quinine is partially masked and not infrequently patients especially among the Indians would take quinine in this form when they objected to the crude drug.

On the other hand for the prophylactic treatment of malaria, where the parasites as a rule are present in the blood in fewer numbers, I preferred the more insoluble forms as absorption was slower and the blood accordingly contained quinine for a longer time, in this way the parasites were more likely to come under its influence and further, the individual was not so liable to symptoms of quininism.

The ~~Eu~~quinine by reason of its tastelessness I found ~~of~~ great value in the treatment of children as they frequently strongly resented the bitter taste of the other forms mentioned. I give from 50% to 100% more of the ~~Eu~~quinine per dose than of the sulphate.

The following routine treatment by quinine, I adopted as being most satisfactory in the treatment of the general run of malarial cases and with effect a certain cure unless the case is of more than ordinary severity. Then, in event of its failure I had re-
or
course to hypodermic intramuscular injections of quinine which I believe to be the most effective method

of administration, but of course as a routine treatment of every case, is not practicable. Recommended by Dr. Oswaldo Cruz in anti malarial campaign, S. Brazil (contribution by Dr. Oswaldo Cruz, Ross, Prevention of Malaria 1910).

On the patient first coming under my observation I administered P. Hydrarg-Subclor, grs.v (to an adult) which ensures a good evacuation of the bowels and I believe in this way does much to lessen the occurrence of gastric or abdominal symptoms either at the time or supervening on the attack, such as excessive nausea and vomiting, diarrhoea and possibly dysentery.

Then when the temperature is beginning to fall, quinine Bisulphate grs. XV is administered in form of cachet. The point of giving quinine at this time being on the presumption that it reaches the blood just at the time when the fresh generation of spores are in free circulation, their sporulation having caused the rise in patient's temperature, and at this phase in the life cycle of the parasite, quinine has the most toxic effect and also one helps to avoid symptoms of quinism superadded to the already distressing symptoms of the patient while in the hyperpyrexial state with its attendant headache.

I administered grs XV on the two following days making 3 doses in all. Then after an interval of 1 day, 3 further doses grn XV given on alternate days. On the completion of the 2nd course of quinine 6 days were allowed to elapse when the 3rd course was begun, which consisted of grn XV every 6th and 7th day for 2 months.

If during this period there is a recurrence of malaria the treatment is begun as before, but this is the exception.

The following is a chart of the quinine administration I adopted, the days on which the doses of quinine given are coloured red.

Table No. 11.

Day of attack		1 st	2 nd	3 rd	4th	5 th	6th	7 th	8th	9th			
1st course					2nd course								
10	11	12	13	14	15 th	16 th	17	18	19	20	21	22 nd	23 rd
3rd course lasting 2 months.													

If The fever still recurs in spite of this treatment, I give gramme 0.5 of quinine Bihydrochloride inter-muscularly just after the temperature of patient has begun to fall usually selecting the Deltoid as site of infection in preference to glutens maximus usually recommended, as I think less inconvenience is caused to patient a second and third infection is given on the two successive days and then if fever is cut, treatment with quinine by the mouth is continued as before, but if it still persists injections are continued on alternate days. This treatment seldom fails.

This method of administering quinine at the periods stated above and in full doses I have found preferable to that of giving smaller doses of quinine at more frequent intervals for the reason already stated, that we get a maximum quantity of quinine brought into action against the parasites at the most susceptible time in their life cycle. Tables 12 and 13 compiled from treatment of my cases in San Lorenzo give practical proof of the relative value of the two methods as applied to the average cases met with in Gujuy.

⁴¹Ross (Prevention of Malaria Ed. 1910) and ⁴¹Celli (Journal Tropical Medicine, April 1st 1908) are more in favour of smaller doses while Koch on the other hand and with him Ollwig and others of the German School recommend large doses at longer intervals (Prevention of Malaria, Ross 1910)⁴³.

The following case of malaria as a type of the average met with, illustrates well the result of treatment I recommend above.

Segundo Frit. Chilian, aged 39 years, Dec. 23rd 1910.

Disease. Sub Tertian Malaria.

History. 11 days ago ate water melon, then bathed staying in water considerable time. Same night fever and vomiting occurred, ceased following day. Since has had quotidian fever, one day occurs in the morning

the next in the evening.

Average duration of fever.

8 a.m. - 3 P.M.

12 o'clock - 6 p.m.

Fever is preceded by rigors. Has taken no quinine
admitted hospital 23rd Dec. 1910 at 2.30p.m.

Dec. 23rd. Temperature on admission 39°C . (102.2°F .)
Pulse 120.

Calomel grs. v given, good result, no quinine.

Blood examined 6 p.m. parasites present
(L.Malaria)

Dec. 24th. Temperature fell by crisis at 10 p.m. was
subnormal. Patient had a marked rigor, Temp. falling
to 96.8°F ., followed by fever. Temp. rose to 103.2°F .,
at 10 p.m. had fallen to 99°F .

Quin Bisulph. grs XV cachet 9 p.m.

Dec. 25th. Morning Temp. sub normal, 2 p.m. slight
rigor Temp. fell to 97.12° rose to 100.4°F at 6 p.m.
at 10 p.m. was sub normal again.

Quin Bisulph. qu. XV 8 p.m.

Dec. 26th. No rise in Temperature all day.

Quin. Bisulph, grs XV 8 p.m.

Dec. 28th. No further rise in Temp. occurred.

Quin. Bisulph. grs. XV alternate evenings for
three doses.

Jan. 2nd 1911. No recurrence of malaria. In 3

TEMPERATURE CHART.

DISEASE.

Sub Tortica Malaria

Name { *Segundo*

Age { *39. yrs*

Diet { *no. 3.*

Case Book No. *3*

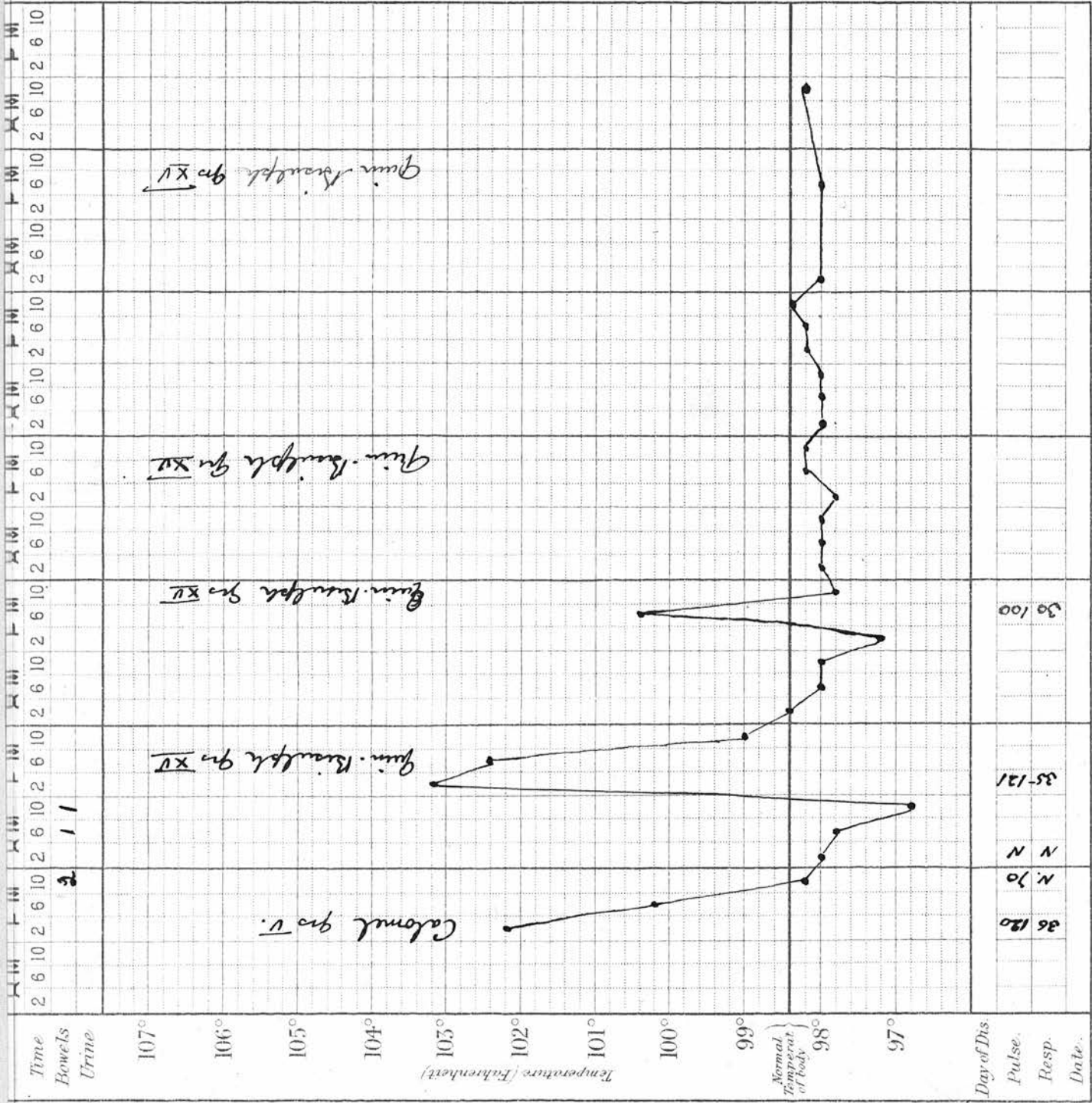
Notes of Case

Date of admission

33rd Dec 1910

Result

Cured



blood slides no parasites found. Patient discharged Hospital, to attend out-patient department once a week.

Jan. 7th 1911. No return of malaria.

Quin. Bisulph. grs XV and on two successive days each week according to chart for a period of 2 months.

After History. Patient again seen in March no return of malaria in the interval.

The following tables compiled from cases treated in San Lorenzo show the results of treatment by the two methods mentioned above, i.e. larger doses at longer intervals on the one hand and smaller doses at shorter intervals on the other.

Table No. 12.

100 cases of malaria (60% children under 10 yrs, 40% adults) treated by grs. XV quinine once daily, 3 days in succession, followed by full doses on alternate days for 3 doses. Then by injection quinine Bihydrochlor gramme 0.5 for 3 days further in any cases still resisting treatment by the mouth.

Type of Malaria.	Sub Tertian.	Tertian.	Quartan.	Mixed infection.	Irregular.	
No. of cases treated.	30.	37.	9.	6.	18.	100.
No. of cases in which malaria continued at end of 1st 3 days - 1st course of quinine.	4.	3.	1.	1.	3.	12.
No. of cases in which malaria continued after 2nd course of quinine.	1.	0.	0.	1.	1.	2.

Type of Malaria.	Sub Tertian.	Tertian.	Quartan.	Mixed Irreg- Infec-ular. tion.
------------------	--------------	----------	----------	--------------------------------------

No. of cases still resist- ing treatment which contin- ued after Injections of Quinine.	0.	0.	0.	0.	0.	0.
---	----	----	----	----	----	----

Table No. 9 also shows a similar result as above where treatment although differing somewhat is based on the same fact i.e. that larger doses are preferable to smaller more frequently repeated.

100 cases of malaria (57% children under 14 yrs and 43% adults) treated by $\frac{1}{2}$ doses of quinine Bisulph. (grs. $7\frac{1}{2}$) twice daily, night and morning, for three days over a further period of 6 days. Then by injections of quinine Hydrochlor. gramme 0.5 for 3 days in any cases still resisting treatment by the mouth.

Table No. 13.

Type of Malaria.	Sub Tertian.	Tertian.	Quartan	Mixed Ir- infecreg- ular
------------------	--------------	----------	---------	--------------------------------

No. of cases treated.	29	41.	5.	11.	14.	100.
--------------------------	----	-----	----	-----	-----	------

No. of cases in which malaria continued at end of 1st 3 days, 1st course of quinine	11.	8.	2.	3.	.5.	29.
--	-----	----	----	----	-----	-----

No. of cases in which malaria continued after 2nd course of quinine.	3.	3.	1.	1.	2.	10.
--	----	----	----	----	----	-----

No. of cases still resisting treatment which continued after 3 in jections of quinine.	1"	0.	0.	0.	1"	2.
--	----	----	----	----	----	----

" Both these cases cleared up on continuing treatment by injection.

From these tables it will be seen 29% of cases treated by small doses of quinine continued to resist treatment at the end of 3 days. As against 12% when larger doses at longer intervals were employed and 10% at the end of 2nd course is against 3%

In the case of children I adopted the same treatment giving doses of quinine proportionate to age of child, about gr1 per year of child's age, of the Bi sulph. up to grs vii and grs. $1\frac{1}{2}$ of ~~Bi~~ quinine up to grs.x.

Routine Symptomatic and Constitutional Treatment.

If there was much nausea while the attack lasted I prescribed a simple effervescing mixture to be taken in small quantities, frequently, which usually gives considerable relief, such as Sod Bicarb. and Acid Hydrochlor. dilutum.

If vomiting is severe a Hypodermic of morphia gr.
 $\frac{1}{4}$ with atropine gr. $\frac{1}{100}$ does much to relieve it.

Dyspepsia frequently occurs subsequent to an attack of malaria if this be present. I believe it is usually due to a temporary deficiency in the secretion of the gastric juice I have found the following mixture useful in these cases.

Tc. Nucis Vom. $\mathfrak{z}i$

Ac. Hydrochlor $\mathfrak{z}ii$

Tc. Zingiberis fort. $\mathfrak{z}i$

~~Aq. Zingiber~~ Aqua $\mathfrak{z}vi$

Sig. $\mathfrak{z}ss$ t.i.d. Ex. aq. $\frac{1}{2}$ hr. p.c.

(with or without the addition of pepsin)

For the anaemia following repeated attacks of malaria, I have prescribed the following:

Ferri Mart. $\mathfrak{z}ii$

Liquor Arsen. $\mathfrak{z}ss$

Aq. Ad. $\mathfrak{z}vi$

Sig. $\mathfrak{z}ss$ t.i.d. Ex. aq. p.c.

For patients run down in health and subject to recurrent attacks of malaria in addition to giving quinine as described above and after an initial course of iron I have found arsenic given in the following manner very beneficial both as an aid to throwing off the recurrent malaria and improving the general condition.

Liq. Arsenicalis $\mathfrak{z}ss$

Aq. Ad. $\mathfrak{z}i$

Sig. 4 drops three times daily, increased to 12 drops by 1 drop every 3 days, then decreased by 1 drop every 3 days back to 4 drops 3 times a day.

The treatment is then discontinued for 2 weeks and then repeated. Larger doses of arsenic tend to have too loosening effect on the bowels.

In the treatment of the various myalgic pains frequently met with among those who have suffered from malaria, especially when subjected to falls in atmospheric temperature and consequent every body chill, which I believe are of a toxic nature. I find that in addition to quinine the following is very useful.

Pot. Iod. *3ii*

Liq. Arsenicalis. *3p*

Sp. Ammon Aromat. *3ii*

Aq. ad. *3viii*

Sig. *3p* t.i.i.d. Ex. aq. p.c.

As regards Dietetic treatment of malaria, during the attack food is repellant to patient, barley water iced if possible is grateful or lemonade freshly made between the attacks and for some days after a light diet is indicated preferably meat free, unless a little chicken or fish be allowed if asked for.

Headache. If headache be a very prominent symptom Phenacetin grs. X given before quinine is administered generally has a beneficial result.

Summary and Conclusions.

1. The belief held by some of the old residents in Jujuy that malaria was due to causes other than mosquitos, as in the early days of colonisation, there were few or no mosquitos, is open to scepticism. The same assertion has been made in connection with other malarial countries and afterwards proved erroneous.

I think its fallacy may be explained as follows: Formerly the stegomyia and culex did not exist as it is an established fact that they made their appearances in San Pedro and San Lorenzo, only within recent years. These two ~~geni~~^{geni} attract more attention than the genus anopheles from the fact that they bite during the day and that they make a much louder hum in a room. Also, generally speaking, they breed closer to houses, in the various receptacles capable of containing water, though I found the anophelines will also breed in such places; still their more typical breeding places are further afield in the swamps and pools of water, etc. Consequently, they will not attract so much attention ~~and~~ their distribution with regard to houses, will not be so patchy and confluent as will be the case often with stegomyia and culex. Taking these facts into consideration, together with the fact that the residents in the former pioneer days took absolutely no means of protecting themselves against mosquito bites.

The house had no wiregauze nor did they use nets round their beds. On this account they were fully exposed to the bites of any existent mosquitos which probably were practically all infected as malaria was ripe among all classes.

One will find today, districts round San Lorenzo where culex and stegomyia are non existent where the inhabitants will declare there are no mosquitos, yet on investigating anophelines are found.

2. The malarial area is increasing of late years in the Argentine. The fact that the country is opening up forms populated centres, which the erection of factories clearing of forest lands and laying down of railways, entail excavations and formation of places in which water all of which can collect by favouring mosquito breeding, tends to the increase of malaria. Cultivation of the land, however, by levelling off and draining the pools, etc. helps to counteract this to an extent.

The Railway Construction through the province of Jujuy to Bolivia has been the means of spreading malaris into districts where it formerly did not exist as is the case in Embarcacion, formerly a sparsely populated now a large encampment, where malaria is rife, from where it is being spread north to the Chaco.

3. The Indians coming down to the Malarious districts of San Lorenzo, Ledesma and San Pedro are the means also of carrying malaria back with them to the Chaco,

where the indigenous anophel es soon become infected. Malaria a few years ago did not exist in the Chaco.

On this account prophylactic and curative measures should be carried out thoroughly and carefully among the Indians when they come down country for the sugar cropping.

4. The clearing of forest land if carried out during the rainy season is associated with malaria, as it entails excavations in order to clear out the roots of the trees , where pools of water may form and mosquitos breed and as there are sure to be some of those employed harbouring the plasmodium of malaria it quickly obtains a footing. Consequently, all excavations should be filled in at once and any pools of water existent be thoroughly oiled and kept so. Also prophylaxis thoroughly carried out by quinine.

5. The land occupied in the cultivation of sugar cane which in the provinces of Jujuy, Salta and Tucuman is a large area, does not predispose to malaria though irrigation is carried on to a large extent as surface water is indispensable to the growth of the sugar cane. The explanation is as follows: The water by a well laid down irrigation system is quickly distributed over a large area, passing along little trenches between the lines of cane, added to this the irrigation is intermittent, different parts of the fields being watered

watered each day. In this way there is not time for formation of pools in which mosquitos might breed. The water is quickly absorbed due to the fact that the sugar cane is a plant which takes up a large quantity of water by the medium of its roots, and as quickly gives it off to the atmosphere by the medium of its leaf area.

6. The splenic index among children is an accurate and ready means of calculating the amount of malaria in a district relative to the population, even more accurate than blood examinations which are liable to fallacy, owing to the fact that parasites may be passed over when present. Number of children in the San Lorenzo district having parasites in blood (see tables No. 1 and 2) are much less than those quoted by Allwig in Africa.

7. *Anopheles pseudopunctipennis* is the mosquito principally concerned in the spread of malaria in the Argentine. They will not breed in water contained in receptacles such as tanks placed at a height above the ground of at any rate, over 20 feet, as seen in the case of the railway tracks along the line and the tanks at the Esperanza factory, although *stegomyia* and *culex* will.

8. Contrary to generally accepted view, relative to other countries, (malaria Prevention 1910 Ross) I found *anopheles* larvae not uncommon in the water contained in

the various receptacles round dwellings, if they are not much raised above ground level. Therefore, it is important to see that all receptacles capable of containing water round or close to any dwelling house should be removed or else emptied and kept emptied of water.

9. Prophylactic treatment of malaria should aim at both destruction of mosquitos and their larvae, but also at systematic and thorough quinine distribution.

10. Living under zincroofs predisposes in hot weather to malaria unless a thick thatch be put on the roof of some material such as brushwood, owing to the depressing effect constitutionally of the conducted heat on occupant.

In San Lorenzo the used up tannin bark proved very useful in the filling up of existing ponds of water which were difficult or impossible to drain. The expenditure of labour being much less than would be the case with earth. As tan yards are fairly common in the Republic it is often procurable and when available should be used for this purpose.

11. Mosquitos in common with gnats and sand flies show a greater tendency to bite just before and just after a heavy fall of rain. This is one reason that malaria is prevalent in the rainy season, another being that fresh pools are formed in which mosquitos breed.

After a heavy fall of rain in a district, three subsequent miniature epidemics of malaria may frequently be noticed.

(a) Immediately after the rain or during it, composed of recurrent cases induced by the lowering effect on the system of the individual attacked, caused by associated sudden fall in atmospheric temperature and wettings, etc.

(b) About 2 weeks afterwards, caused by the increased biting of mosquitos before and after the rainfall.

(c) About 4 weeks later due to the infection from the fresh generations of mosquitos, hatched out in the pools, formed during rains. These mosquitos having taken approximately 2 weeks to hatch out and roughly 2 weeks more for parasites to produce febrile reaction in the individual inoculated.

Consequently during the rainfall and for a month after, quinine prophylaxis should be energetically pushed and the pools of water oiled.

13. Quinine Administration.

Prophylactic. Best given in grs. XV doses on two successive nights each week. This should be continued all through the malarial season (September to June).

Curative. The best method is intramuscular injection grs vii per adult daily for the first 3 days

(given immediately after fever has subsided, so as not to increase the distress of the patient by the addition of quininism) then on alternate days for 3 more injections.

But resort to the intermuscular injection is not always necessary as grs. XV given by the mouth during some period and with some frequency is usually sufficient and will cut short most cases. Then prophylactic treatment as above is commenced and continued for 2 months.

14. Arsenic arranged in form of increasing and then decreasing, scale is very useful in chronic cases in addition to quinine or where patient is much pulled down by attack.

15. Malarial Relapses.

There are no primary attacks of malaria during the months of June, July, August, September and October as a rule. Attacks occurring in these months occur only among those who have had malaria before and are for the most part relapses, as mosquitos are practically absent in these months.

Malaria is apt to recur in persons exposed to conditions producing a depression of bodily vitality, such as fatigue, or wasting illnesses, such as typhoid, pneumonia or phthisis. But I believe there is another exciting cause namely alterations in blood pressure in the internal organs, the spleen and bone marrow es-

No Evidence
found

pecially, thereby washing out into the general circulation any parasites which in accordance with the generally accepted theory lie dormant in the tissues from a previous attack and now take on an active phase with the result that young generations of parasites are found in the blood of the subject followed by an access of fever. I have not unfrequently noticed in my own case, and also among others, that I have had malarial attacks following closely on some extra exertion, where the blood pressure had been considerably raised, though no apparent devitalising effect produced.

Change from a low attitude to a high one of consequently rarified atmosphere will foeten bring on a recurrent attack of malaria, although the individual may feel braced up by the change and in the best of health right up to the time attack occurs. I believe that in these cases the change in blood pressure acting as above is an important factor in the production of the relapse.

The sudden falls in atmospheric temperature that one is exposed to in the Argentine must and do have a devitalising effect on the system, especially in the case of Europeans, resident for a long time in the country and will consequently predispose to a relapse of malaria.

Yet, owing to the contraction of the cutaneous blood vessels the blood pressure in the internal organs is

raised as evidenced by increased kidney secretion, so that we have the same element in the production of the relapse in these cases also.

The eating of quantities of unripe fruit by the natives and Indians, such as oranges, grapes, water mellons and unripe sugar cane undoubtedly do cause a considerable percentage of the recurrent cases. Now, as diarrhoea was usually associated with these cases, possibly the consequent alteration in blood pressure is here also an auxiliary cause in the production of the relapse.

16. From the point of view of prevention of malaria the eating of unripe fruit and more especially unripe sugar cane which is consumed in large quantities by Indians and natives should be prevented by the public authorities.

17. Immunity.

There is evidence of partial immunity in the Argentine in as much as malaria is more common among the Indians, who come from a part of the country which up to a few years ago was free of malaria, and whose ancestors presumably did not suffer from it, than it is among the Argentines of San Lorenzo who live in a malarial district and whose progenitors in many cases were subject to it. The Indians are more prostrated by the attacks and show a larger percentage of cases

per cent of the population while resident in San Lorenzo than do the natives.. In support of this theory Ross states that probably some immunity occurs owing to the formation of what probably is an antibody (Ross & Prev. of Malaria 1910)⁴⁶.

18. Myalgias seen in chronic malarial subjects or in those who had malaria at a former date, are I think of toxic origin. It is an accepted supposition that in malaria there is a toxine formed (Ross Prev. of Malaria)⁴⁷. On this ground I think it is legitimate to trace the muscular and aponeurotic pains so frequently met with in those who have formerly suffered from malaria, when they are exposed to sudden drops in temperature to the same cause. What occurs is probably one of two things (1) either the opsonic index of the individual exposed to devitalising influences is consequently lowered and the toxine already existent for the moment gets the upper hand over the antibodies, so the myalgias are produced as result of the toxæmia, there probably not being enough parasites present to produce an access of malarial fever or they may not lose their latent character, simply excreting toxine without forming fresh generations of parasites. (2) or possibly the toxic element is brought into evidence following on the change in blood pressure in the internal organs, the result of the surface of the body being chilled. As a result of the raised blood pressure in spleen

and bone marrow, parasites lying dormant there are washed out into general blood stream a toxaemia being set up as a consequence.

19. I think there is a large field still open for research in the question of the serum treatment of malaria, One might work on the lines of Wassermann's reaction, forming antigen by dissolving the human red corpuscles by an antihuman corpuscular serum and centrifugalizing to get the parasites.

20. As a result of the prophylactic measures adopted in the San Lorenzo District malaria has been very materially decreased with a comparatively short period as shown by a comparison of the malarial index.

Malarial index 1909 - 13.8%

Malarial Index 1910 - 8.3%

Malarial index calculated on the month of May:

1908 - 28.8%

1909 - 13.6%

1910 - 6.4%

Prevention only commenced in early part of 1909.

21. Atypical forms of certain of the Tertian parasite (*Plasmodium Vivax*) are common. When sporulating the number of spores are often only 12-15 and the "granules of Schuffner" are absent.

22. Generally speaking in San Lorenzo and Jujuy increase in the malarial index is associated with a/

corresponding high rainfall in atmospheric temperature

(See Tables 6 and 7)

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